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THE

# PHILOSOPHICAL MAGAZINE.

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NUMBER XIV.

JULY 1799.

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ILLUSTRATED WITH

THE FOLLOWING ENGRAVINGS BY MR. LOWRY.

1. A 4to Plate relative to the Structure of the Crystals of Oxyde of Tin.
  - A Plate illustrating the best Construction of the Vanes of Windmills, so far as concerns the Angle of Weather.
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LONDON:

PRINTED FOR A. TILLOCH:

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Number XIII. is illustrated with a Plate of Figures to explain Volta's Theory of Galvanism—Apparatus employed by Dr. Van Marum for the Combustion of Phosphorus in Oxygen Gas.

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AUGUST 1799.

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1. Mr. MÜSSET's Pyrometer for ascertaining the Heat of an Assay-furnace.
  2. VON HAUCH's New Discharging Electrometer, laid before the Royal Society of Copenhagen. And,
  3. HUMBOLDT's Portable Barometer for Travellers, &c.
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L O N D O N.

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*Mackenzie sc.*

*Roger Joseph Besenrich*

THE  
PHILOSOPHICAL MAGAZINE:

COMPREHENDING  
THE VARIOUS BRANCHES OF SCIENCE,  
THE LIBERAL AND FINE ARTS,  
AGRICULTURE, MANUFACTURES,  
AND  
COMMERCE.

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BY ALEXANDER TILLOCH,  
MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY.

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"Nec araneorum sane textus ideo melior, quia ex se fila gignunt. Nec nostris  
villior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 2.

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VOL. IV.

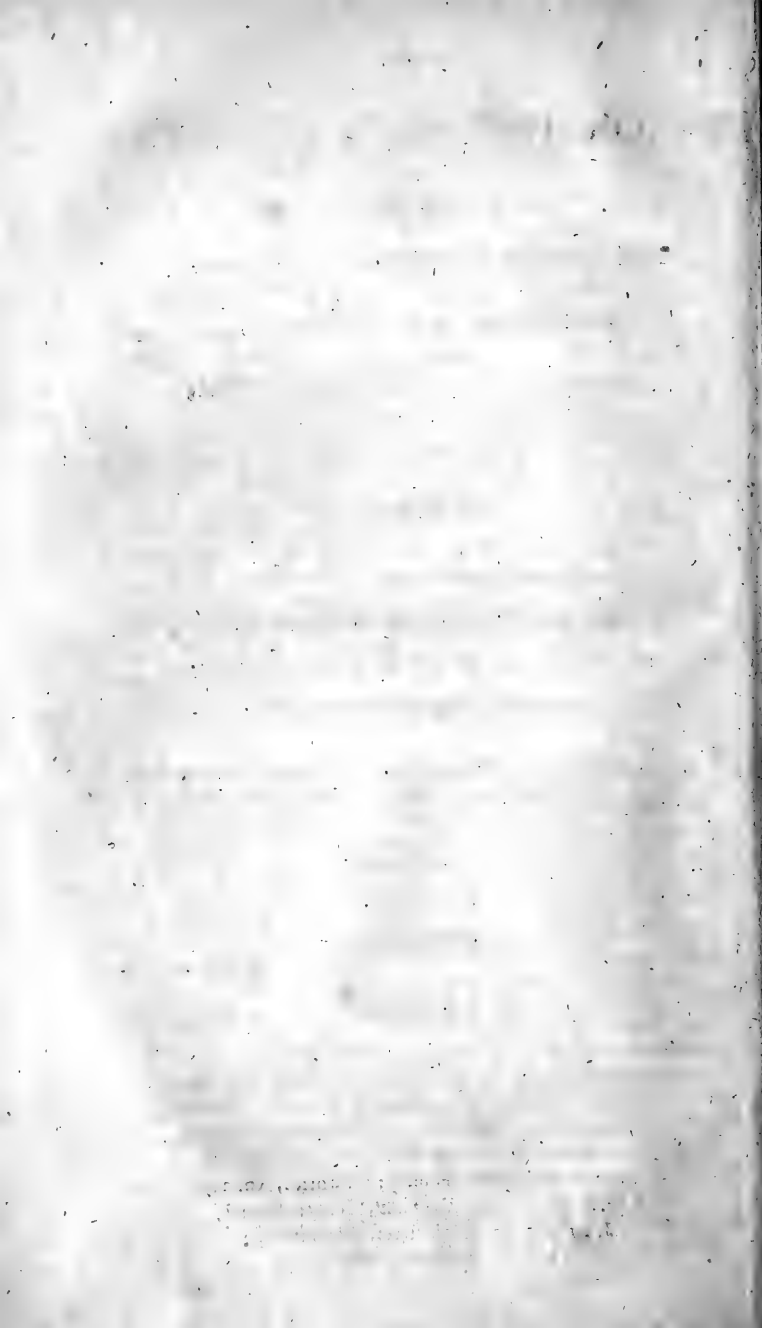
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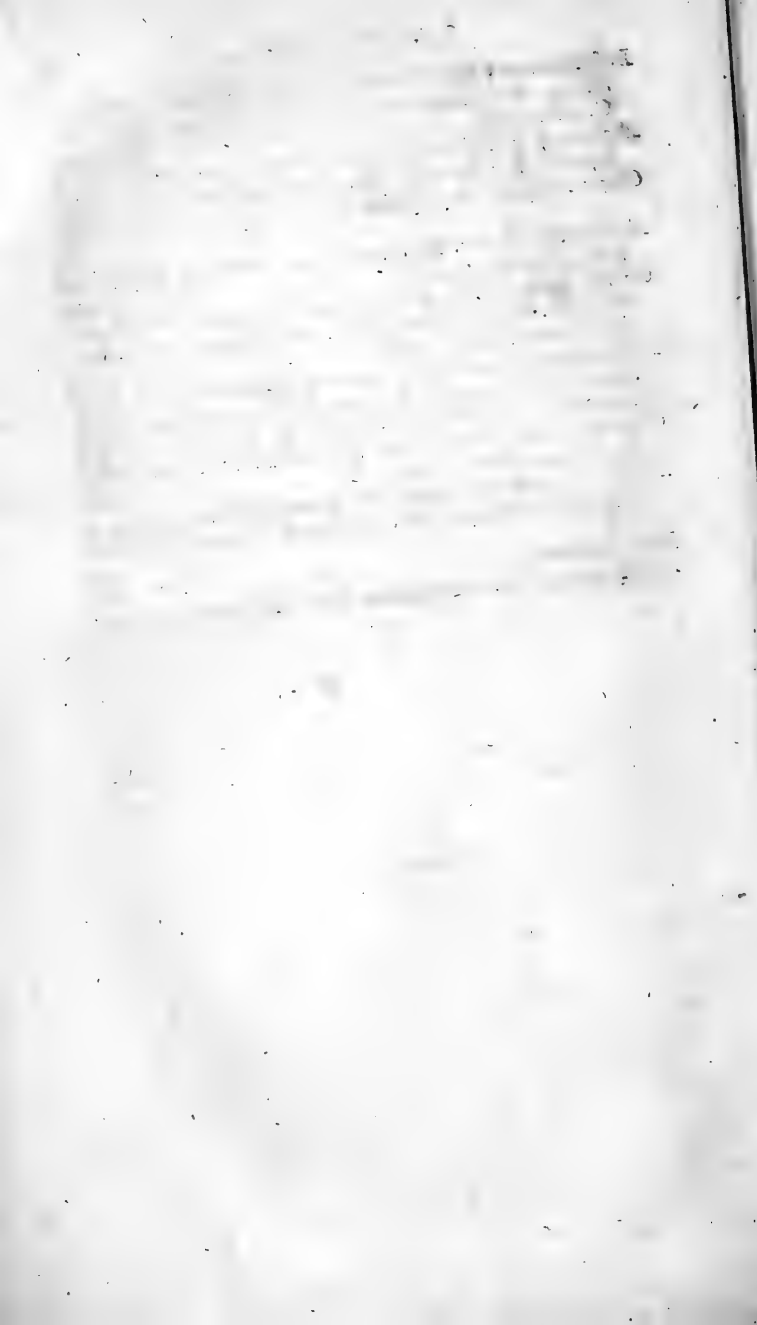
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THE  
PHILOSOPHICAL MAGAZINE.

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JUNE 1799.

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- I. *On the Possibility of Casual Mutilations in the Bodies of Animals becoming in the Course of Time hereditary Marks of Distinction.* By Professor BLUMENBACH \*.

THAT it is possible for mutilations produced in the bodies of animals, either by accident or by artificial means, especially when repeated through a whole series of generations, to degenerate in the course of time into hereditary marks of distinction, seems *à priori* to be incontrovertible. At any rate, I should be glad to see the physiologist who can assign a reason why this should not be as possible as the transmission of hereditary organic diseases, or hereditary monstrosities †,

or

\* From *Magazin für das Neueste aus der Physik*. Vol. VI.

† Of the numerous and partly well known instances of this kind I shall quote only a recent one, mentioned by M. Schulz in his *Observations on a monstrous canary bird*, p. 17. "A Spanish bitch," says he, "which had been in my possession for several years, was not only brought forth without a tail, but at various times produced puppies some of whom were destitute of tails also. As often as this bitch brought forth more than one puppy, one of them perhaps was quite perfect; the greater part, however, had half tails or tails still shorter, and one at least had no tail at all. The most singular thing was, that the young almost always had a resemblance

or the most individual traits in family likenesses, such as a thick under lip, strong eye-brows, and so on, which certainly did not all descend from Adam; but which have first appeared at a certain generation, and since that period have been continued, with more or less constancy, by hereditary transmission.

### *I. Instances among Animals.*

We are told by Sir Kenelm Digby\*, that the tail of a cat having been cut off when young, some of the kittens, which she afterwards brought forth, were always without tails. Nath. Highmore†, who in explaining the nature of generation differs so much from Sir Kenelm, says that he saw a bitch which wanted almost the whole tail from the rump, and that the half of her young were brought into the world with tails, and the other half without. Buffon‡ asserts that he saw dogs, the ears and tails of which had been cropped for many generations, and which transferred this mutilation, either totally or in part, to their posterity.

M. R. Masch, of New Strelitz, gives an account, in the *Naturforscher* §, of a butcher's dog, the tail of which, according to custom, had been cut off, and which having copulated with a she-wolf, that had been caught, the latter produced three bastards. Among these was a male, half grey like the father, and born with a cropped tail; so that the casual mutilation of the dog, as the author says, was transferred to this bastard.

We are told by D. Forster ||, that it has been remarked in to the father, whether grey-hound, spaniel, &c. in regard to colour and bodily conformation; and derived nothing more from their mother, the Spanish bitch, than the singularity of having only the third part of a tail, or no tail at all."

\* On the Nature of Bodies, p. 214.

† History of Generation, p. 31.

‡ Histoire Naturelle, vol. xiv.

§ Part xv.

|| Beyträge zur Völker-und Länder-Kunde, Part 1.

England, that when horses are continually docked, and both stallions and mares kept so for many generations, the foals, at last, come into the world with some articulations fewer in the tail. Buffon \* has enlarged pretty fully on this subject, and endeavoured to prove, by the help of anatomy, that the callosities on the breast-bone and knees of the camel are merely the consequence of their subjection, and the force by which these animals of burden, as is well known, are obliged to kneel down; and as the young camels, when brought forth, have callosities of the like kind, he gives this as a proof of the hereditary transmission of such variations produced by art.

## II. Instances among the Human Species.

Cardan † speaks of the well known ancient custom of the Peruvians of *Puerto Viego*, who pressed between boards the heads of their new-born children. This custom, however, became afterwards like a second nature; so that, in the course of time, children were brought into the world with heads formed in that singular manner: and Cardan expressly says, that this flatness of the head was originally the work of art, and not of nature. *Conflat igitur*, to use his own expressions, *humanam formam multis modis variari, tum arte, tum diuturna successione*. Hippocrates, in his work upon air, water and climate, mentions something of the like kind in regard to the *Macrocephali*, a people on the borders of the Black Sea, who pressed the heads of their new-born children; and this practice repeated, through many generations, produced at length an hereditary distinction; so that the children were born with heads of a particular form. “At first,” says he ‡, “the practice of the country seems to have been the cause of this conformation; but custom afterwards be-

\* Histoire Naturelle, vol. xi.

† Vol. iii. p. 162 of Spon's edition of his works.

‡ This passage is translated from the original in Chartier's edition, vol. vi. p. 206.

came nature. Those who had the largest heads were considered as the noblest; and for this reason the *Macrocephali* pressed the yet pliable tender heads of their children with their hands, and forced them to extend in length by bandages and other means. This artificial process gave occasion to the subsequent increase of size in the head among these people, so that artificial means were no longer requisite for that purpose." Hippocrates, however, adds in a short section: "That in his time their heads had no longer that singular form completely, because they had entirely neglected the above artificial means of formation." But that this very little contradicts his preceding account and opinion is shewn by the intermediate passages, where he endeavours to explain the phenomenon from his well known theory of generation. "The generative matter," says he, "is collected from all parts of the body. From sound bodies it comes sound, and from diseased bodies diseased. Now, as bald heads, blue eyes, and overgrown bodies are transmitted in families, and the like rule takes place in other circumstances of conformation, why should not children with great heads be produced by great headed parents?" Hippocrates, therefore, evidently meant only that in the course of time Nature sometimes abandons forms she has assumed, and returns again to the original.

Aristotle, in his work on the generation of animals, speaking of the grounds on which the theory of Hippocrates respecting generation is founded, says: "It is very probable for this reason, besides others, that children not only resemble their parents in internal and innate properties, but even in external marks which are merely casual; for there are instances of moles being transmitted from parents to their children, and on the very same parts of the body. He himself quotes a Chaldean, who, having a mole on his arm, transmitted it to his son, though in the latter it was not so apparent as in the father. Pliny also, where he treats of marks, moles, and the like, being sometimes inherited by children,

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adds, by way of example: *Quarto partu Dacorum originis nota in brachio redditur*. In my opinion, this passage alludes to the hereditary transmission of moles among the Dacians, Illyrians, &c. who, according to the testimony of many of the Ancients, were distinguished by this singularity.

The late M. Osann once came to me, full of astonishment, and told me that he had met with a similar instance in the family of a staff-officer, who lived in the neighbourhood. The father in his younger days had received a wound in the little finger of his right hand, which had been rendered crooked during the cure; and his son and daughter were born each with the little finger of the same hand crooked. I have since seen both the father and daughter, and have been convinced, by inspecting their hands, of the truth of the above information.

A literary man of very great acuteness, when conversing with me on this subject, started the following objection: "If artificial mutilations can become hereditary, children born of circumcised parents must often be born without the foreskin, which does not appear to be the case." At that time I was acquainted with only one instance of this kind in Steph. Gerlach's Journal; but one example did not appear to me to be of any peculiar weight. I, however, once happened to ask a Jew of this place, a man not destitute of learning, and well acquainted with the ritual of his nation respecting this circumstance, and was told that it frequently happened that the children of the Jews were brought into the world with so short a foreskin that it required an experienced and careful hand to circumcise them. This innate deficiency is distinguished by a particular Hebrew appellation, *nauld mohl*, or born circumcised. His own father, who had circumcised above 700 boys, and who was celebrated on account of his expertness in this case, not at all uncommon, often spoke of the difficulty of performing the operation under such circumstances. In a word, what had appeared to me an argument against the hereditary transmiss-

sion of artificial mutilations, became unexpectedly an important argument in its favour. I will, however, readily acknowledge, that all the cases above mentioned may not be of equal authenticity, and equally incontrovertible; but even though the least improbable should be rejected, there will still remain, to support the probability of the thing, as many as could be desired for a proposition which cannot well be proved by direct experiments made for the purpose.

II. *Report on the Travels of C. OLIVIER and C. BRUGUIERE, undertaken by order of the French Government, through the Ottoman Empire, Egypt and Persia, during the Years 1792, 93, 94, 95, 96 and 97\*.*

[Concluded from the last Volume, p. 347.]

THIS journey was extremely interesting; for, besides the great number of objects which we collected, and the observations we had occasion to make, we were surprised to see a country exceedingly fertile, yet almost a desert, and often volcanic, exhibiting, at every step, vestiges of ancient cities. We crossed the Euphrates and the Tigris on wretched wooden boats; and two rivers, which flow from the mountains of Curdistan, on boats formed of a number of inflated skins joined together. I shall describe, with some minuteness, this simple method of crossing rivers, because it might be employed with advantage in Europe, on account of the facility and trifling expence of transporting a great number of skins; of inflating them in a moment, and uniting them firmly together by means of the branches of trees; and of conveying, in this manner, over the largest rivers, a whole army without any danger.

When we arrived at Bagdad, the pacha was so ill that two Persian physicians, who attended him, had given over all

\* Read in the Sitting of the National Institute, February 14th. By C. Olivier.



hopes of his recovery. His astrologer had read in the stars the fatal sentence; the kiaya pacha and some of the grandees were already forming intrigues to succeed him, and the janissaries were taking up arms to sell their services to the highest bidder. The Arabs of the desert, and of Mesopotamia, waited only for the moment of his death to plunder the caravans and rob travellers. This city was threatened with a general insurrection. Commerce was suspended; and it was impossible for us to continue our journey. The pacha begged us to give him our advice, until we should have an opportunity of setting out for Persia. We thought ourselves bound to comply with his request, and had the satisfaction to restore him to health in the course of a few days. From that moment order was every where re-established; and the kiaya alone paid, with his head, for the steps he had taken to assume the place of his benefactor. The pacha shewed us every mark of gratitude, made us a present of two fine Arabian horses, and gave us letters of recommendation to the khan of Kermancha, and the ministers of the king of Persia.

We did not delay a moment to provide ourselves with Persian dresses, and whatever else was necessary; and departed on the 16th of May 1796, with the regret of leaving behind us a box containing several very valuable jewels, destined as presents to the Persian court, which the envoy of the republic at Constantinople was to have sent after us.

The usual heat at Bagdad, during some hours of the day, is from  $110^{\circ}$  to  $113^{\circ}$  Fahr. On the day of our departure the thermometer was already at  $99\frac{1}{2}^{\circ}$  Fahr. We had here an opportunity of seeing a phenomenon which explains the origin and cause of that singular and transitory wind which destroys men and animals, if proper precautions are not taken to guard against its effects.

On our arrival at Kermancha, the first city of Persia, we waited on the khan, made him acquainted with the object of our travels, and delivered to him the letter from the

pacha of Bagdad. The khan asked us many questions respecting the different states of Europe, with which he seemed to be little acquainted, and respecting our manners and customs. He dwelt most on the countries of the Ottoman empire which we had traversed, and particularly Bagdad, because in that city the ashes of Ali are preserved. He gave orders to one of his officers to accompany us to court, and procured us the necessary passports. On the 1st of June we arrived at Teheran, where we learned that the king and his ministers had set out in the beginning of spring on an expedition, the object of which was supposed to be the conquest of all Chorazan.

I was highly pleased with the idea of undertaking this journey, and I considered it as a fortunate circumstance that the king was at the head of an army in one of the most interesting provinces of Persia; into which no European traveller had penetrated, and which produces the most remarkable plants, as well as the greater part of the drugs brought to us from the Eastern countries; but C. Bruguiere had been ill for a long time, and was threatened with a dysentery. The dragoman himself was indisposed, and reasons were not wanting to dissuade me from undertaking the journey. "It is not positively known," said some, "where the king is; and it is dangerous to approach the army in this country, because people are plundered, and even killed, before they can be known and protected. It will require more than a month to reach Chorazan, and the king must return in two." These reasons did not counterbalance the advantages which were likely to result, from this journey, to natural history and geography; but I reflected that the health of my colleague was becoming daily worse, and that he was incapable of supporting the fatigues of travelling so far, during the hottest season of the year. It would have been necessary to traverse the Mazandaran, a hot, marshy, and extremely unhealthful district; and besides this, the dragoman refused to accompany us. We then agreed to wait

wait for the king in the environs of Teheran, in order that we might take advantage of the season proper for researches in regard to natural history; for collecting seeds, and for enabling C. Bruguiere to re-establish his health with more facility.

We were obliged to negotiate, and to make some pecuniary sacrifices, before we could obtain permission to quit the town, and reside in a village at the bottom of mount Albours. Teheran contained hostages from all the great cities of the empire, whom Mehemet had caused to assemble there for his security; so that people might enter the city, but could not depart from it without the express leave of the governor; and the latter did not let slip so fine an opportunity of forcing us to expend a little money. As we foresaw that the presents left behind might be retarded, and not even reach us, we thought it prudent not to make any mention of them. We had it in our power, indeed, to offer the governor a watch and some arms; but we should thus have entered into an engagement to give other presents to his principal officers, and, on the king's arrival, having nothing sufficiently beautiful to offer to his ministers, and our presents being detained at Bagdad under a pretence that the roads were not safe, we should have been considered as impostors, and should have lost that confidence which our conduct ought to have inspired.

The king, after taking possession of Meshed and all Chorazan, and after having destroyed Charok-Shah the last descendant of Thamas-Kouli-Khan, and carried away his treasures, returned to Teheran. He made his entry into that new capital towards the end of September 1796; and, two days after, we had an audience of the prime minister, with whom we had reason to be satisfied. We endeavoured to secure the friendship of the chief secretary, an active, judicious, enterprising man, and as well informed as could be expected in Persia. We spoke to him of the new government established in France; and, at the same time, made him

him acquainted with its resources, population, triumphs and power. We received from him some interesting details respecting the manners, religion and government of the Persians, as well as a circumstantial history of the troubles which had desolated that unhappy country since the dethronement of Shah Hussein, and particularly since the death of Nadir Shah.

On the 4th of October we obtained from the minister an audience to take leave; and, some days after, his principal secretary gave us a letter addressed to the French republic, a copy of which I immediately dispatched, reserving the original, which I have since presented to the directory.

We now made haste to complete our observations and to return to Bagdad, as we already foresaw the storm which still involves that country in all the horrors of a civil war. We quitted Teheran on the 15th of October, and pursued the road to Ispahan. We had made an ample collection of objects of natural history, and of medals. We had acquired also very correct information respecting the population, revenues and forces of Persia; the late revolution, and the state of its commerce. Our travels, however, would have been incomplete, had we not seen the ancient capital of the empire, and the seat of the sophis. We remained a month at Ispahan, and on the 21st of December arrived at Bagdad.

Some European travellers have traversed Persia, and have given us accounts more or less correct of that empire. They have made us acquainted with the industry and commerce of the Persians; given us long details respecting the religion and followers of Mahomet; and have described the palace and gardens of Shah Abbas and his successors, as well as the public edifices of Ispahan. But the history of the troubles of Persia since the death of Nadir Shah; the changes in manners, agriculture and industry, which must have been effected there by intestine wars, that continued for more than sixty years; the formation of a new empire, more powerful than Persia itself, which extends from Candahar to  
Cassimire,

Cashmire, from Caboul to the country of the Moguls, comprehending the fertile banks of the Indus, cannot fail of giving new interest to a new narration. In regard to natural productions, it will be seen, by an account of the different objects which I shall not fail soon to publish, how little they are known, and how curious and important the greater part of them are.

Persia is an elevated country, covered with snow in winter from the Caspian sea to Ispahan; and in summer, dry and exceedingly warm. It consists of mountains remarkably high, and of immense plains, for the most part uncultivated. What must astonish every traveller is, that throughout the whole empire no production can be obtained without watering: neither corn nor vines grow there but by means of water. No trees or shrubs are ever seen, but such as have been planted, reared and watered by the hand of man. Water is every where necessary; and yet in this country it is naturally wanting. It was requisite, therefore, that the industry of the inhabitants should supply this deficiency by subterranean channels, which convey water from all quarters, and end at a common reservoir. By taking advantage of the declivity of the ground, they then draw off different streams, near which they form habitations more or less considerable, according as the water, more or less abundant, admits of a greater or less degree of cultivation.

Though wounded, at the distance of six days journey from Bagdad, by a band of Curdes, while assisting my colleague when about to fall into their hands, I was, however, soon able to continue our journey; but C. Bruguere, whose life was almost daily threatened in Persia, and whose health was still uncertain, could not for a long time be prevailed on to proceed. Nearly six months elapsed before I was able to persuade him to set out in order to return home. Several times, on the approach of the fine season, did I threaten to leave him; but I could never resolve to do so, as my conscience

science would not have ceased to reproach me, had my companion, after my departure, terminated his career at a distance from his friend and fellow traveller.

During the time I resided at Bagdad waiting for the perfect re-establishment of C. Bruguier's health, I employed myself in collecting different materials for a history of our travels. I have seen the ruins of Seleucia, Ctesiphon, the site formerly occupied by the celebrated Babylon; the towers called those of Nimrod, which neither time nor the hand of man has been able entirely to destroy, and which still excite the admiration of travellers.

I had in Egypt and Syria observed the Arabs, that nation so singular, and respecting whom travellers have spoken so differently. I had studied their manners, their customs, and the form of their government. It still remained for me to live among them, to travel with them, to frequent their tents, and to receive from their hands simple, frugal, and wholesome food.

As particular circumstances obliged me at Bagdad to exercise the functions of a physician, I readily embraced that opportunity of seeing the interior part of the Mahometan habitations, and of becoming acquainted with the state of their harems, and the women shut up in them. No traveller, perhaps, has been able to collect, in this respect, so many singular anecdotes.

We departed from Bagdad on the 1st of May 1797, in company with a caravan destined for Aleppo. We remained sixty-five days on the banks of the Euphrates, and in the desert employed our time in preparing plants, collecting insects, skinning birds and quadrupeds, and in making observations on the Arabs; the climate, soil, and productions of these countries. We made only a short stay at Aleppo, where we found a letter from C. Aubert Dubayet, in which, after some compliments on account of our conduct, he requested we would return by the shortest route to France.

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This invitation was perfectly agreeable to our wishes; but it was indispensably necessary that we should pass through Constantinople. Could we leave behind us a scattered collection, the fruit of five years labour and observations, exposed to the dangers of the sea and of dilapidation? Is it not certain that objects of natural history, almost all of a perishable nature, must be taken care of during quarantines by hands accustomed to manage them? How easily might manuscripts have been carried away? We had left some boxes under the care of a merchant at Constantinople, and others in an apartment of the ambassador's palace. There was a great number at Scio, and some at Latakia. We considered it as our duty to unite the whole, and to convey them all to Paris ourselves, in order that it might be seen, on our arrival, whether we had accomplished the views of government, and whether we had not deceived the expectations of the learned.

We wrote to the ambassador to make him acquainted with the motives which induced us to take the way of Constantinople. We wrote, at the same time, to the consuls of Tripoli and Cyprus, begging them to inform us when the first ship sailed for the Archipelago; after which we repaired to Latakia, where we found only a wretched Venetian ship, in which the consul advised us not to embark, as the Algerines, for some time past, had insulted the flag of that expiring republic. We then resolved to proceed to Cyprus, and to traverse that island, though in the most dangerous season; to repair afterwards to the coast of Caramania, and to proceed thence to Constantinople, by crossing Asia Minor. This journey was one of the most interesting we undertook, both in regard to natural history and the information we collected respecting the manners of the Turks, in a country little known, little frequented, and yet so worthy of attention.

We arrived at Constantinople in the end of October, and should have departed thence in the Sericuse, some time after,  
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had we received our boxes from Scio, and those we left at Cyprus. The ambassador was employed in procuring us a passage in the Brune to Athens and Corfu, just at the time of his death. After that event, all our efforts to procure a safe and direct passage to France being useless, we thought we should be sheltered from all danger, and free from all reproach, if we proceeded to our isles in the Levant, by crossing the isthmus of Corinth. It was certainly of much importance for us not to fall into the hands of the English, whose ships covered the Mediterranean. It would have given us great pain to see our enemies profit by our labours, and reap the fruit of all our dangers and fatigues.

We wrote to C. Carra Saint Cyr, *chargé d'affaires* of the republic at the Ottoman Porte, to inform him of our plan, and obtain his approbation; and at the same time to ask some pecuniary assistance, and make him adjust the statement of the sums advanced to us since our arrival in the Levant. We received a favourable answer, and such as was suited to our circumstances.

It may not be superfluous here to observe, that we had for a long time reminded the Porte of the services we had rendered to it in regard to the pozzolana; a service it perhaps thought it had sufficiently rewarded by the flattering letter which the Reis Effendi charged us to deliver to the minister of foreign affairs, accompanied with a present of 2000 piastres. We should certainly have refused, from any other government, a sum so small and so ill proportioned to our labour, expences, and the importance of the discovery, and, in particular, so far below the promises made to us; but a government so little susceptible of honest and generous conduct, would not have been sensible of the motive of our refusal.

We left Constantinople with a favourable wind on the 30th of April, in a Turkish boat we had hired; touched at one of the castles of the Dardanelles, and different points of



the Troade, and, for the second time, traversed that fertile country. We paid a visit to the ancient site of Troy; saw the sources of the Scamander; went along the shores of the Simois, and thence proceeded to examine the ruins of the Troy of Alexander. We stopped half a day at Ipsera; went on shore at Cape Sunium to see the remains of the temple of Minerva, and arrived at Athens on the 6th of May. We did not remain above twenty days in that city, which exhibits so many beautiful monuments, and calls to remembrance so great events. I have brought with me a plan of the ancient and modern city, by Fauvel; and one of Marathon, which I traced out on the spot. I collected information respecting the present state of Athens and the neighbouring country, to compare it with what it was formerly. I have seen Mount Hymettus, the marble quarries of Pentelica, the cities of Eleusis and Megara. We passed through the Straits of Salamis, where the Persian fleets were destroyed; and traversed the Isthmus to embark again on the Gulph of Lepanto, from which we repaired to Patras.

It was time to terminate our observations on the Ottoman empire, and to quit these countries, now barbarous, though formerly the seat of the arts, sciences and philosophy. It was time to place ourselves under the ægis of the republic. We arrived at Corfu on the 14th of July, after having touched at Cephalonia, Ithaca, and Parga. We performed quarantine for 21 days. It was not yet finished, and we began to think of continuing our journey through Italy, though embarrassed with a considerable collection, when C. Comeyras, commissary general of the directory, arrived. We immediately applied to him in order to procure a passage to Ancona. He gave us reason to hope that he would soon assign to us for that purpose a small vessel belonging to the republic; and, in the mean time, I traversed the island and environs, sometimes alone, and sometimes with my colleague, to procure information respecting the natural productions of  
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the country; the state of agriculture, and the improvements that might be made in it; its ports and harbours; the timber of Epirus fit for ship-building; the commerce of these districts, and the manners and opinions of our new French subjects. On the 23d of August, and 6th of September, I delivered to C. Comeyras two memoirs, the one being a continuance of the other, in order that he might transmit them to government.

On the 9th of September we sailed in the Brune frigate for Butrento, where we spent the day, and arrived at Ancona in the course of a few days. My colleague, who had been almost always indisposed and in a state of suffering since our tour through Persia, here terminated his career, on the 3d of October 1798, in consequence of a malignant fever brought on by fatigue. He has left a family in want, whom I doubtless have no need of recommending to the benevolence and justice of the government.

I have brought with me, from the countries I have travelled through, a pretty large collection of plants, seeds, quadrupeds, birds, reptiles, river fish, insects, shells and minerals, as well as of medals, engraved stones, and other objects of antiquity. I have Egyptian idols and mummies; a selection of drugs, most of them unknown in Europe; a series of the medicines employed in Persia; and, in the last place, some rare and valuable manuscripts. I have just sent to the national garden of plants, seeds from Persia, Mesopotamia, the desert of Arabia, Syria, Cyprus, Asia Minor and Greece, in order to be there sown and cultivated. A great number of those which we sent home before, have been already reared, and are in a thriving condition.

### III. Method of preparing the Dutch Turnsol Blue\*.

**I**T is well known that the Dutch kept their process for preparing turnsol blue a very great secret; and, in order to mislead the public, pretended that it was made from rags dyed with the juice of the sun-flower (*Helianthus*), from which it obtained its name. Since the late revolution, however, in Holland, the true method employed by the Dutch for preparing this colour has been discovered, and the process is as follows:—That kind of lichen called orchil (*Lichen roccella*), or when that cannot be procured, the large oak moss, after being dried and cleaned, is reduced to powder, and by means of a kind of oil-press the powder is forced through a brass sieve, the holes of which are small. The sifted powder is then thrown into a trough and mixed with an alkali called *vetas*, which is nothing else than the ashes of wine lees, in the proportion of half a pound of ashes to one pound of powder. This mixture is moistened with a little human urine, for that of other animals contains less ammonia, by which a fermentation is produced; and the moistness is still kept up by the addition of more urine. As soon as the mixture assumes a red colour, it is poured into another trough; is again moistened with urine, and then stirred round in order that the fermentation may be renewed. In the course of a few days it acquires a bluish colour, and is then carefully mixed with a third part of very pure pulverised potash; after which the mixture is put into wooden pails, three feet in height, and about half a foot broad. When the third fermentation takes place, and the paste has acquired a considerably dark blue colour, it is mixed with chalk or pulverised marble, and stirred well round that the whole may be completely united. This last substance gives the colour no higher quality, and is intended merely to add

\* From the *Handlungszeitung*, by J. A. Hildt, for December 1798.

to the weight. The blue, prepared in this manner, is poured into oblong square iron moulds; and the cakes, when formed, are placed upon fir boards on an airy floor in order to dry, after which they are packed up for sale.

IV. *On the apparent Conversion of Silver into Gold.* By  
Professor HILDEBRANT, of Erlangen\*.

**T**HOUGH gold and silver have this common property, that they shew little affinity for oxygen, and their calces can therefore be revived merely by ignition; their difference in other respects is so great, that scarcely any two metals can be more unlike. Not only is their colour totally different, and the specific gravity of gold far greater than that of silver, but silver, in the dry way, forms a perfect union with sulphur; and in the wet way, with the sulphuric and nitrous acids; whereas gold has no affinity for these substances.

If the transmutation of metals were therefore possible, the conversion of silver into gold would be very improbable. We must, however, consider nothing impossible in nature, the impossibility of which cannot be demonstrated *à priori*. Each century, and, in the present active age, every short period of a century, discovers new phenomena, some of which are of such a nature that they would be considered as impossible, were not their reality fully confirmed by experience.

I entertain no dread then of being ridiculed by the unprejudiced philosopher, if I call the attention of chemists to a phenomenon in which silver appears to be converted into gold. It is a well known process, which I repeat in every course of my Lectures, to dissolve silver that contains copper in pure nitrous acid, to precipitate the pure silver by common salt (muriat of soda), in the form of horn silver (muriat of silver), and then to separate the silver from the latter by fusion with mineral alkali. An experienced chemist as-

\* From *Allgemeine's Journal der Chemie*, by A. N. Scherer, 1799.

fured me, that when silver is revived in this manner, it is in part converted into gold. Since that time I have frequently re-dissolved in pure nitrous acid the silver which I obtained from horn silver, and always found a small quantity of black powder remaining at the bottom, which seemed to have all the properties of gold.

My process for reviving the horn silver is perfectly simple: I pour into a deep crucible a bottom of alkali an inch high, and form in it a hemispherical cavity with the round end of a cupel rammer. I then put the horn silver, well pounded, and mixed with as much alkali (neither of them moistened), into this cavity, cover the whole with a thin stratum of alkali, and apply a slow heat, till the whole mass comes to red fusion; by which means the revived silver is enabled to sink down and collect itself at the bottom. As vegetable alkali (potash) produces the same effect as the mineral (soda), I employ the former because it is cheaper. I find by experience, that, to form a moist ball of the horn silver and alkali, is not only unnecessary, but even prejudicial; for the moist mixture is tenacious, and unavoidably adheres to the fingers and the vessels, thereby causing waste. As the horn silver is so extremely fusible, and at the same time a flux for earths, and as it easily penetrates the crucible, the principal object in reviving, according to the above method, is to increase the heat by very slow degrees, suffering the charcoal to burn only gently for two hours around the bottom of the crucible, that the horn silver may be in a state of fusion before the crucible has been long ignited. By these means the alkali is enabled to join itself gradually to the muriatic acid, and at the same time so completely that, when the heat is increased till the alkali is in a red fusion, there is no longer horn silver but metallic silver present, which therefore may come in contact with the crucible without any danger.

For dissolving the revived silver I employ nitrous acid, which I first purify of oxytes from the sulphuric acid, and

afterwards by silver from the muriatic acid. It cannot here be discovered how gold could be conveyed to the silver by the solvent and precipitant employed; and therefore, to appearance, a part of the silver is actually converted into gold. Enlightened chemists, however, will scarcely believe in this transmutation, and will rather suspect some deception. I confess that I do not myself believe in it, and I explain the appearance of gold from the revived horn silver in the following manner:—Notwithstanding the great difference between gold and silver, some silver is almost always present in pure gold; and a little gold is in like manner almost always present in pure silver (in those commonly called pure). The case is the same in these metals when worked, particularly in coins, even where they are not alloyed one with the other. In all the ducats I have hitherto tried, even in those of Holland, I found, on dissolving them in aqua regia, a little silver deposited in the form of horn silver. In all French crowns, even in the fine Harz florins which are perfectly free from copper, I found a little gold, which, when they were dissolved in the nitrous acid, was thrown down in a dark coloured precipitate, which could not proceed from the alloying. Dutch ducats, for example, are not, as far as I know, alloyed with silver; and no one certainly will believe that the gold found in the Harz florins and French crowns was purposely added to them. The metal of these coins has from nature a small portion of foreign metals; the gold a little silver, and the silver a little gold, as long as it is not purified by quartation—or the gold by antimony. If a solution therefore be formed of such silver, the gold remains undissolved, and gradually deposits itself at the bottom as a fine black powder.

It may be readily comprehended, that every chemist, unless he has very little experience in such processes, when he wishes to precipitate silver as horn silver, will first pour off and filter the clear solution of silver and copper from the black gold powder, before he adds the muriatic soda. On  
a hasty

a hasty view, one might conclude, that the gold which is afterwards found in the same silver, when revived from horn-silver, could not be a portion of the same gold of which a part had been deposited on the first solution of the impure silver. But is it not possible that even when the solution has stood a considerable time, and the greater part of the gold powder has deposited itself, a portion may still remain suspended, and its particles be so minute as to pass through the filtre? A well diluted somewhat ferruginous acid, after diluted prussiat of potash (phlogisticated alkali) has been added to it, looks at first blue, but perfectly transparent; yet in the course of a few days real Prussian blue deposits itself at the bottom as a fine powder, and then the fluid loses its colour. The particles of the precipitate are at first too fine, and appear under too small angles, to be distinguished by the eye as solid bodies amidst the fluid. The case is the same with siliceous earth, when the liquor of flints is much diluted; and also with gold calx precipitated with the mineral alkali from aqua regia, where the transparent colourless ley poured off from the first precipitate, and filtered through eight folds of paper, at the end of several days again forms a black deposit.

As my time is fully occupied with the processes necessary for my Lectures, I have not leisure at present to examine this circumstance by a series of experiments. But, perhaps, some other chemist, by repeatedly dissolving silver and precipitating it by muriatic salt, may be enabled to confirm or refute my opinion.

*Observations on the foregoing Paper, by Dr. SCHERER.*

THE preceding remarks are greatly confirmed by many observations already made public. Thus Homberg, in support of his assertion that all gold has been once silver, quotes the following experiments: "If you fuse a hundred times in succession 8 or 16 ounces of silver, which, by previous quartation, you are convinced contains no gold, keeping it each time at least an hour in fusion, and afterwards separate

it by the quart, you will be able to separate a considerable quantity of gold, which was not before in it, because you separated by the first quartation all the gold it could contain. Farther, dissolve 8 oz. of silver in aquafortis, separate all the undissolved part, add to it common salt, and edulcorate the precipitate you have obtained and dry it. Mix with it half its weight of well purified regulus of antimony prepared with iron, and distil the whole in a retort over a slow fire. About 3 oz. or more of the butter (muriat) of antimony will pass over, and, when the fire has been strengthened to the utmost, the silver will remain with a part of the regulus at the bottom of the retort. Fuse this silver in a crucible until no more vapour arises, and until all the regulus is evaporated. Then fuse this silver once or twice more in new crucibles with a little borax and saltpetre, and it will become much more beautiful and finer than cupelled silver. If you then granulate this silver and dissolve it in aquafortis, a great many black scales will remain behind, and, on fusing, you will find them to be gold. If you repeat this operation once more with the same silver and a like regulus, a few black flakes only will remain; and the third time there will be none\*.” Boerhaave says, in his *Elements of Chemistry*, “If two parts of the precipitated calx of silver, well mixed by trituration with one part of regulus of antimony, be distilled in a retort in a sand bath, pure butter of antimony, equal in weight to the regulus added, will pass over. The silver, with part of the regulus, will remain at the bottom; and, when reduced, always gives real gold†.” Kunckel‡, in like manner, ob-

\* See *Memoires de l'Academie de Paris* for the year 1709, p. 133; and Crell's *Neues Chem. Archiv.* vol. i, p. 30.

† Si enim calcis præcipitatæ argenti partes duæ, cum reguli antimonii parte una, tritu bene mixtæ distillant ex retorta, igne arenæ, prodit purum butyrum antimonii tanto pondere, quo fuit regulus admixtus. Argentum cum parte reguli manet in fundo, et reductum semper dat verum aurum. *Elementa Chemiæ.* Lipsiæ, 1732. Tom. ii. p. 413.

‡ See his *Chem. tractälein.* p. 146.



tained gold by treating silver with common salt. M. Cappel, by treating silver with arsenic, obtained from four ounces ten grains of gold \*. Guyton confirms this experiment, and observes that, in this manner, 8 grains of gold are obtained from 1000 grains of silver †. The arsenic, in the last cases, was combined with gold. Some very important results, in regard to this subject, might be obtained by examining the works of the ancient alchemists, as all their assertions respecting real transmutation might be explained by mere separation, without allowing them so much as some have done ‡.

V. *History of Astronomy for the Year 1798. Read in the College de France, Nov. 20. By JEROME LALANDE, Inspector and Dean of the College, and formerly Director of the Observatory.*

[Concluded from the last Volume, page 389.]

I SAW at Strasburgh the first sheets of a new map of Swisserland constructed by M. Weifs, to whom M. Tralles communicated his triangles and bases. This map is extremely well engraved, and gives us an interesting topography of Helvetia.

I paid a visit, in my passage, to the observatory of Mannheim, which had afforded me so much pleasure in 1791; but I found the instruments packed up in boxes and deposited in vaults which the bombs had scarcely respected, and waiting there for peace, without which neither science nor happiness can exist. The minister d'Arberg, whom I requested to second the zeal of M. Barry, shewed me every mark of friendship.

\* Crell's *Neueste entdeckungen*, vol. x. p. 136.

† Crell, *ut supra*.

‡ See Crell's *Neues Chem. Archiv*, vol. i. p. 212.

On the 15th of December 1797, Tycho Brahe's birthday, Dr. J. Ch. Burekhard arrived at my house. This able astronomer, born at Leipzig on the 30th of April 1773, came to reinforce the astronomical corps in France; and he is engaged in a German translation of Laplace's *Mechanique Celeste*, or *La Theorie de l'Attraction*, now in the press. This important work will give the last degree of perfection to our tables: two hundred pages of it are already printed.

On the same day I requested General Bonaparte to procure a good instrument for the observatory; and on the 19th of March the government granted me 2000 livres to purchase the seven and a half feet mural quadrant of C. le Monnier. We had long solicited good instruments for the observatory. C. Cassini, when director in 1785, had obtained a fund for that purpose from the minister Breteuil; but he had not time to make use of it. When I was director in 1795 I renewed my solicitations, and we were at length able to procure, the first time, for the most beautiful observatory in the universe, an instrument worthy of France\*. The *Bureau des Longitudes* has sent thither an achromatic telescope; but that is not sufficient.

On the 30th of April I requested from General Bonaparte 10,000 livres to erect the mural quadrant and the meridian telescope of the observatory; and to make at Paris observations to correspond with those made by his astronomers. He departed too soon; but Neufchâteau, the French minister, is worthy of remedying that deficiency, and gives us reason to hope for the assistance we stand in need of. C. Lefrançais observed, with a complete circle, the solstices of this year; and I have seen, with pleasure, that the obliquity of the ecliptic corresponds, within a second or two, with the table which I gave in my *Astronomy* in 1792, and which is employed by most astronomers.

\* The expence of building the observatory is estimated at a million of livres (40,000*l.*), without including the foundations and subterranean places eighty feet in depth.

On the 20th of June the Institute decreed the prize for time-keepers, used in ascertaining the longitude at sea, to two chronometers made by C. Louis Berthoud, the going of which was observed by C. Messier and myself during six months. I carried one of them to Gotha; and I had the satisfaction of finding that a journey of two hundred leagues, in a carriage, did not make the change of a second per day in its movement. The Institute will propose, on the 4th of January, as the subject of a prize to be adjudged in two years, the theory of the comet of 1770, which was proposed by the Academy in 1792. It has not hitherto been possible to calculate this comet but in an orbit of five years, and a revolution so short is improbable.

The *Memoirs of the Institute* for the Year IV. have appeared. They contain my *Theory of Mercury*, the result of forty years researches. This was the first memoir read in the first sitting of the first class of the Institute, on the 1st of January 1796.

The *Bureau des Longitudes* has published two volumes of the *Connoissance des Temps* for the years VIII. and IX., the additions to which were edited under my inspection. It has determined that this work, in future, shall contain 500 pages, in order that we may insert in it our observations and calculations. These two volumes contain a number of important articles: new catalogues of the stars; tables of the moon's horary motion by Delambre; observations of Mercury by Vidal, the great and astonishing observer of that planet, to whom we are indebted for being able to say that the observations of Mercury, so rare and so difficult before his time, are at present as numerous as those of the other planets, and leave nothing more to be wished for on that head. He has alone done more than all the other astronomers of the world, either ancient or modern; and we may now dispense with employing our attention on that subject. C. Vidal must make every other astronomer despair of exceeding him.

An interesting memoir, accompanied with a trigonometrical chart, serving to reduce the apparent distance of the moon from the sun, or from a star, to the true distance, and to resolve other questions of navigation, has just appeared, by J. R. Maingon, *lieutenant de frigate*. This ingenious chart, of great utility to the navy, was engraved by order of the minister, and published at the *dépot*. It will supply the place of the large charts of Margetts, and enable navigators to substitute operations with a pair of compasses for calculation.

The Geographical Ephemerides, undertaken by M. von Zach, of Gotha, at the commencement of the year, are a remarkable and useful work, as there are found in them every month curious observations; information respecting new books and charts, new voyages and geographical maps, such as those of Ireland, Africa and the Black Sea, of so much importance at a time when the public attention is directed towards these countries; also portraits, such as those of Herschel, Delambre, Sir Joseph Banks, &c.; in a word, every thing that can be interesting to astronomers, geographers and navigators. An extensive correspondence with all countries enables M. von Zach to form a mutual communication between learned men, even the most distant from each other. The only inconvenience is, that the German language is not sufficiently cultivated in the South. I have requested that a professor of German may be established in the *College de France*, as I am fully convinced of the importance of that language to various branches of science. No journal was devoted to astronomy and geography; and there was little reason to hope that any of the kind would be undertaken. Adelbulner and Bernoulli had attempted it without success. The high esteem in which M. von Zach is held, has given to his work a sufficient degree of reputation to ensure a sale, and consequently the continuance of this useful publication.

M. Martonfi has published, in Transylvania, a description  
of

of the observatory constructed by Count Bishop Bathyani at Carlsburg or *Alba Julia*, called also Weiffembourg and *Alba Carolina*.

M. Triefnecker, of Vienna, has published a considerable work on eclipses of the sun and planets. He has calculated more than 150 observations, and the tediousness of such labour is well known. Scarcely any thing of the kind had been done in 1760, when I began to give an example of these calculations.

We are informed that a volume of Bradley's observations, so long expected, has been published at London. M. de Mendoza published, also at London, in 1797, researches in regard to solving the principal problems of nautical astronomy, with tables of versed sines for every ten seconds, and an auxiliary table which reduces the discovery of the true distance to the addition of five versed sines.

We have received the Ephemerides of Bologna for twelve years, from 1799 to 1810, by C. Mateucci, assisted by C. Alamanni, Guglielmini, Sacchetti, and Canterzani the son. Since the commencement of the present century, the Academy of Sciences always published the Ephemerides for ten years. The last volumes are by Desplaces, Lacaille and myself. I finished at the year 1800, old style: the embarrassed state of commerce prevented me from immediately finding a bookseller, and I therefore renounced these calculations. The astronomers of Bologna, more fortunate, have supplied this deficiency; and we shall have twelve years materials to assist those who wish to make almanacks for that period.

The Ephemerides of Milan contain the result of an important labour of C. Oriani, on the method of correcting the elements of the tables of Mercury by observation; and many interesting observations of C. Reggio and De Cefaris.

M. Schröter, of Lilienthal, has published the second volume of his *Astronomical Collections*, which, besides other things, contains the apparent diameters of the satellites:  
nine-

nine-tenths of a second for the second; and one second and a half for the third.

M. Bode, at Berlin, has published a new volume of his Ephemerides for the year 1801, and a third supplementary volume; which contain many astronomical observations and memoirs, by the German, French and English astronomers. This work, like that of M. von Zach, is a repertory which no astronomer can be without.

We have received also a folio volume of logarithmic tables, published in 1794, by M. Vega, an officer of artillery in the emperor's service. Wlacq's tables, published in 1628 and 1633, had become exceedingly scarce; they were never reprinted, and yet they were often wanted. M. Vega has, therefore, rendered a great service to mathematics by republishing that valuable edition.

M. Schubert has published, in German, at Petersburg, a large treatise of astronomy, in three volumes quarto, forming altogether nearly 900 pages.

The *Bibliothèque Britannique* of Geneva, for March and April, contain interesting details respecting the method employed by M. Blair to correct the difference of refrangibility in telescopes. Essential oils, a solution of corrosive sublimate in spirit of wine, with the addition of a little sal ammoniac; butter (muriat) of antimony diluted in a little ether or alcohol, mixed with a few drops of the muriatic acid, answered the purpose extremely well, when inclosed between two lenses of crown glass\*. He formed a very good object glass with a solution of sal ammoniac and mercurial sublimate (muriat of ammonia and mercury). He has discovered that these different substances have not a like distribution of colours, as Boscovich remarked in 1765. In short, he has calculated the curves of glasses in such a manner as to correct the aberration of sphericity. This curious paper has been translated into French; but C. Leroy has kept

\* Transactions of the Royal Society of Edinburgh, vol. iii.

back the manuscript for three years. We are obliged to C. Pictet for having made it known in his excellent collection the *Bibliothèque Britannique*: the author calls these telescopes *aplanatic*, or without error.

I have published a new edition of Rivard's Treatise on the Sphere and the Calendar; a well written elementary book, which has been useful for half a century. I have added to it the Republican Calendar, remonstrating against the deficiency of intercalation, as the decree of October the 3d 1798 was not in that respect agreeable to what I had delivered to C. Romme.

C. François de Neufchateau signalised his entrance into the ministry by ordering an Astronomical Bibliography to be printed. I brought with me from Germany a great many articles for this work; and I have found that no kind of bibliography can be complete without the co-operation of many persons in different countries. The period of the death of the great Copernicus was still a problem, which I resolved during my journey. He died on the 11th of June 1543, though Gassendi and Weidler say the 24th of May, and Planche the 11th of July, in the interesting collection of Ephemerides, where the memorable events of each day are recorded. I have caused more than sixty manuscripts to be examined in the national library. C. Legrand, one of the librarians of that celebrated repository, gave me an account of many others; so that we are making advances in this part of astronomical erudition.

We have received the observations of C. Ratte at Montpellier, C. Thulis at Marseilles, and C. Vidal at Mirepoix: those of the last-mentioned astronomer are of a very extraordinary kind. C. Vidal saw Mercury at the distance of three-fourths of a degree from the sun. The beauty of the climate, the perfection of his instrument, and the excellence of his sight, have produced observations as valuable as singular: I have spoken of them before.

The

The direction of the observatory at Amsterdam, belonging to the Society *Felix Meritis*, has been entrusted to M. Calcoen. He has been at Gotha to exercise himself with M. von Zach; and has begun a course of observations which will be useful in a country where none were ever made, though the want of a navy must induce the government to open their eyes in regard to an object so necessary to navigators. In vain did I go to Amsterdam in 1774; the Stadtholder and the Grand Pensionary promised every thing I wished, and did nothing. M. van Swinden afterwards made some exertions, the effects of which begin to be felt.

C. Henry, who went from Mannheim to Peterburgh, has been able to restore activity to the observatory of that capital. He has caused to be erected the large mural quadrant by Bird, which had remained a long time in the packing-box, and which Rumowski never made use of.

M. Piazzzi, the astronomer of Palermo, is preparing to measure a degree. I have sent him an exact metre, and they are employed on a complete circle.

The minister, Pleville-Peley, has increased the salaries of the astronomers belonging to the marine observatory at Marseilles, where Thulis makes continued and important observations.

The survey of Corsica, or description of that island, begun thirty years ago, has been finished. The large triangles were laid down by C. Tranchot; the minuter operations were performed by a great number of assistants. The minister of finance having commissioned me to examine this labour, I have reason to think that it is sufficiently correct to be taken as a model, should a like plan be adopted in regard to all the departments of France, which would be highly useful.

C. Perny, who had been sent to Belgium, and who, since 1795, has formed forty triangles at Bruges, Ghent, Ostend, Antwerp, Middelburgh, &c. has set out for the Batavian republic,



republic, which promises to furnish him with every thing necessary for continuing that labour.

On the 24th of January the Institute proposed to the Directory to request the different powers of Europe to send learned men to France, to assist in establishing the new measures, and to sanction that establishment. Eleven have arrived from Denmark, Spain, Italy and Holland: from Denmark, M. Bugge, director of the observatory, and known by some important works; from Spain, Messrs. Gabriel Ciscar and Augustine Pedrayes; from the Batavian republic, C. van Swinden and Æneæ, the former well known by some excellent works on natural philosophy; from Tuscany, M. Fabbroni; from Sardinia, Count Balbo, the minister at Paris; from Helvetia, C. Tralles; from the Ligurian republic, C. Moltedo; from the Cisalpine republic, C. Mafcheroni, from whom General Bonaparte brought us what will serve as a lesson to our most famous geometricians; and from the Roman republic, C. Franchini.

On the 23d of June the legislative body made a law, that the *Bureau des Longitudes* should preserve the original standard of the metre, or of that new measure destined to be in future the type of all measures, and to prevent hereafter that confusion which has hitherto prevailed in the measures of all countries.

Astronomy has so few profelytes that I am happy in being able to say that Dr. Buerckhardt, who came from Gotha last year, continues to labour with us at Paris, and that he is already one of our best astronomers.

Delambre had as assistants in his immense labour C. Tranchot, already well known by the great operations in Corsica, and young C. Pomard, who devotes himself to astronomy, and who cannot fail to make a rapid progress under such a master. Astronomy has need of a few recruits; and I do every thing in my power to procure them; but the career is laborious, and not lucrative: this is sufficient to explain why we have so few.

Blanpain,

Blanpain, born in 1779, who saw first at Marfeilles the comet of 1797, announces, at the age of nineteen, as much zeal as knowledge. He is distinguished by his great learning and good moral qualities. Being obliged to apply to commerce, he is not yet able to indulge his taste for astronomy; but he calculates observations, and even makes some himself.

Young Bernier, of Montauban, applies also to the same science with success. I wished to get him sent out with General Bonaparte; but my application was too late.

C. Cotilon, though employed in the administration of domains, has come to lodge in the *College de France*, in order to labour along with us. His intelligence and zeal we often find useful.

On the 11th of November C. Caffini V. aged sixteen, who has come to reside in the observatory to pursue the traces of his ancestors, and who displays all the zeal which ought to be inspired by such an illustrious name, made his first observation in the observatory of the *College de France*, under the direction of C. Lefrançois. He will supply the place of Maraldi IV. who has left us.

After having spoken of our acquisitions, I must now speak of our losses. In the history of astronomy for the Year V. I announced the death of Toaldo, which happened at Padua on the 18th of November. As I published a particular eloge of that useful astronomer in the *Magazin Encyclopedique*\*, I shall here add nothing on the subject, except that his place is supplied in the observatory of Padua by his nephew, M. Chiniello, who was a long time his assistant.

Bertrand-Augustin Carrouge, an astronomer of great merit, died on the 29th of March. He was born at Dol on the 8th of October 1741. He calculated a thousand stars for the Celestial Globe published by C. Lamarche, successor to Fortin; and he made a great many calculations for the

*Connoissances des Temps*, and the second edition of my *Astronomy*. He published several memoirs in the *Connoissances des Temps*; and a few days before his death he delivered to me tables for calculating the phases of the moon, better than those which are in Bouguer's and La Caille's *Elements of Navigation*. They are in the *Connoissances des Temps* for 1801. He was exceedingly poor when he was appointed *administrateur general des postes* on account of the esteem which Reveilliere-Lepaux, the director, had for his merit. His new appointment did not prevent him from applying to astronomy: talents rarely conduct to fortune; this only happens when power is united with knowledge.

Alexis John Peter Pauçon died on the 15th of June. He was born on the 10th of February 1732, near Lussan, and is known by his *Metrology*, an immense collection of the measures of all countries, which appeared in 1780. I proposed that labour, and furnished him with the greater part of the foreign measures; but he added many researches, dissertations, and calculations respecting the ancient measures, population and agriculture. He employed himself on other parts of the mathematics, such as the Screw of Archimedes. In the year 1781 he published a *Theory of the Laws of Nature*, in which he refuted Newton and Nollet, and established a new geometrical foot of  $123\frac{1}{4}$  lines. In that work he spoke of the pyramids of Egypt, &c. He was so fully persuaded of the importance of his discoveries, that he assumed this motto: *E putco veritas*. In the last place, he was employed in reducing into decimal measures the immense number of foreign measures, when the economy of government suppressed his salary, and plunged him into wretchedness and despair, which terminated in his death. The Institute is just now soliciting government to grant some relief to his widow and children.

Beauchamp wrote to me, from Arles, that he had lost his  
 VOL. IV. D brother,

brother, the companion of his travels through Arabia; and his pupil Hyacinth Reccieur, who displayed all that zeal and all those good qualities which could be wished. This loss, a very great one to astronomy, threw Beauchamp into despair, and disgusted him with a voyage to Arabia; but the minister sent him to join Bonaparte and the men of letters assembled in Egypt, where he will certainly contribute to the success of that important expedition, in regard to the geographical and astronomical parts.

M. Reccard, who had published various observations, died at Konigsberg on the 3d of October.

We have lost lately also John Francis Calle. He was born on the 25th of October 1744, at Versailles, where he received a good education, and acquired an early taste for the mathematics. In 1768 he came to Paris, where he had an opportunity of being more thoroughly instructed. In 1774 he formed some distinguished pupils for the school of engineers, where the examinations were strict, and admission difficult to be obtained. In 1779 he gained the prize proposed by the Society of Arts at Geneva, for escapements. In 1783 he completed his edition of *Gardiner's Tables of Logarithms*, which were exceedingly convenient, of great utility, and very correct; and which possessed advantages above all the others. In 1788 he was appointed professor of hydrography at Vannes, afterwards at Dunkirk; and in 1792 he returned to Paris, and was for a few years professor *des ingenieurs geographes* at the depôt of war. This place having been suppressed, he continued to teach in Paris, where he was always considered as one of the best mathematical masters to whom pupils could apply.

In 1795 he published the new stereotype edition of the *Tables of Logarithms*, considerably enlarged with logarithmic tables of the sines, according to the new decimal division of the circle. These are the first which ever appeared. Towards the end of 1797 he presented to the National Institute the  
plan

plan of a new telegraph, and a telegraphic language, accompanied with a dictionary of 12,000 French words adapted to it by a combination worthy of so able a mathematician.

These labours had injured his health; he had been a long time asthmatic, and notwithstanding his condition he published, that year, an excellent memoir on finding the longitude at sea, under the modest title of *A Supplement to the Trigonometry and Navigation of Bezout*. He died on the 14th of November 1798, leaving behind him a daughter, born at Vannes in 1793. According to a tradition in the family, he was descended from Descartes. I have not been able to obtain the genealogy of his family; but it is sufficient for the glory of Calce, that he has done honour to a name so celebrated.

VI. *Progress of Dr. MITCHILL's Mind in investigating the Cause of the Pestilential Distempers which visit the Cities of America in Summer and Autumn. Being a Developement of his Theory of Pestilential Fluids, as published to the World in 1795, and the succeeding Years\**.

IT had a long time appeared to him, that what had been mentioned by medical writers and lecturers under the names of *miasma* and *contagion*, was not treated of with the precision and certainty of knowledge, but discussed with all the indistinctness and conjecture of something only guessed at. And, while a student at Edinburgh, he supposed the doctrine taught in the university of the *sedative* operation of these poisons was true, until he heard from Dr. Brown, while attending his lectures, a contrary opinion.

Delivering his sentiments on *stimulants*, Brown had said, "Venena et contagiones incertius eodem spectant." (*Elementa Medicinæ*, cap. 2. § XI.) This implied a doubt in Brown's mind, whether these classes of objects were stimu-

\* From an American Correspondent.

lants or not. This doubt is repeated in § XIX. where, expressing his ideas of the manner the exciting powers act upon excitability, he seems to consider poisons and contagions as exceptions to the general rule of action: “*nisi quod venena et contagiones excipi posse videntur.*” And although, in the two following paragraphs, he endeavours to shew that these substances are *stimulants*, and act upon the living body after the manner of other stimuli, still he is so wholly silent as to their nature and constitution, and so entirely destitute of experimental proof or demonstrative reasoning, and withal so brief and general in his remarks, that nothing solid and satisfactory is afforded in that part of his work which treats of these matters.

In conversation with this original though unfortunate man, Dr. Mitchill acquired incorrect information on the matter of these poisonous substances and their manner of acting; the sum of Brown's reasoning but tending to shew that, as all other substances according to his hypothesis were stimulants, *poisons* and *contagions* could not, from the nature and analogy of things, act in any other way than by stimulation too.

Thus it appeared to Dr. Mitchill, when he returned to America in 1787, that that field of physical science, which included the production, operation, and extinguishment of poisonous fluids, lay almost waste and uncultivated. On turning over the Encyclopædia, there scarcely appeared a subject whose investigation promised greater good to mankind, or fairer fame to the investigator, than the history of these noxious productions. Not long after this time the Medical Society of the State of Delaware proposed a prize-question, “What was the hurtful power which produced the febrile distempers of that region?” And Dr. Mitchill was solicited by his friend Dr. Ed. Miller, then secretary of the society, to compete for the prize. But being at that time engaged in the study of the law, and also in the politics of his country as a member of the legislature, he declined undertaking any

any thing of the kind; but obferved, “ that the mifchievous matter would be found to *be a gas*, and an analyfis of a portion of the atmofphere there would not fail to detect *what fort of gas it was.*”

Being devoted to other purfuits, the fubject of poifons hardly occurred to him afterwards, that he recollects, as a theme for contemplation, until the year 1795, when the following incidents fet him ferioufly to thinking. While on a tour, that fummer, towards the northern country, he had afcended towards the fources of the Kaats-kill, and been engaged among the fublime and picturesque fcenery of the Blue Mountains, in the State of New York. On a fhoulder of the eastern fide of a ridge, called the Pine Orchard, he very narrowly efaped being bitten by one of the rattlesnakes which infest that zone of the mountains. This ferpent, of the full-grown and largeft fize, lay basking in the fun-fhine. The voyager had walked within a foot and a half of him before he was difcovered. The agitation and whizzing noife of his rattle led firft to his detection. When feen, he was bent into a coil, and his head was erected apparently to ftrike. The fuddennefs of the furprife, and the grand and novel afpect of the animal, prevented for a moment the emotions of fear. Dr. Mitchill, however, was foon brought to his recollection by the cries and fhouts of his companions, who were terrified at the extremity of his danger. In the mean time the animal crept quietly away, and Dr. Mitchill efaped unhurt. By the joint efforts of the company, this ferpent and his mate were drawn from their lurking-place and killed. In the diffection of their bodies, in which he was aided by William Cutting, Efq. and others, Dr. Mitchill had an opportunity of examining their fangs, jaws, and receptacles of venom. So narrow an efape, as it induced him to reflect, led him afterwards to conclude, that there was very little of philofophical information to be derived from Mead's *Mechanical Account of Poifons*; and that in

Fontana's *Experiments*, the general exciting cause of plague and pestilence had been left unexplored.

Another occurrence, during that excursion, had directed his attention to the subject of poisons. Dr. William M. Ross, one of the party, had discovered that the *Rhus Toxicodendron* grew at the foot of the Blue Mountains. And a parcel of the leaves and stems of the plant were collected and carried home, with the intent of repeating Alderson's experiments with this venomous vegetable, on persons afflicted with palsy.

From this tour as he was returning to the city of New York, he learned with sorrow at Paughkeepsie, a town eighty miles distant, that a malignant distemper had broken out during his absence, and that among other persons Dr. Malachi Treat, then physician of the port, had been carried off by it. Hastening back with all speed, he saw and conversed with a number of physicians, and found them divided in opinion, whether the yellow-fever, for so the disease was called, existed in the city or not. The majority seemed disposed to doubt or deny the fact. A short time, however, was sufficient to convince all persons whatever, that a sad and terrible malady had made its appearance among the inhabitants.

Impressed as he was with ideas about poisons, it appeared to him at once, that the exciting cause of the endemic sickness of New York, was as much *a poison as the fluids secreted by the rattle-snake or the toxicodendron*. There was a difference, however, between the venom of pestilence and the poisons strictly denominated *animal* and *vegetable*; because the two latter were always the effect of vascular and glandular action with secretion in living bodies; whereas the former was the result of new combinations taking place in organized substances during their putrefaction and decay, without any thing like a secretory function. Herein, then, seemed to consist the distinction between what might be called Com-



COMMON POISON and SPECIFIC POISON; the one being produced by the corruption of dead bodies, the other afforded by secretion going on in living ones.

The decisive method of gaining information concerning this COMMON POISON (*venenum universale*) must necessarily be an examination of every individual process going on during the complicated work of animal and vegetable disorganization. For this purpose Dr. Mitchill had planned a set of experiments. But, before undertaking these, he determined to watch the operation of the poison already produced, be it what it might, and observe in what manner it wrought the destruction of life. And, for this purpose, he remained in the city until the sickness was abating; having omitted no opportunity to witness and collect facts as they occurred in the midst of pestilence and death.

Much observation, and in circumstances where the persons best calculated to make researches in science rarely choose to expose themselves, had led Dr. Mitchill to believe that the history of AZOTE, both in living and dead bodies, would throw a world of light upon this department of physics. Accordingly he went to Plandome, his country residence on Long Island, and became convinced, by experiments made on the air extricated in the abdomen of putrefying animals, that it was not merely *carbonic acid gas*, but consisted also of a large quantity of *azotic air*. It is remarkable, that, to avoid the obloquy too often levelled at experiments, he was obliged to conduct his processes with all possible secrecy.

But *azotic air* alone seemed to possess too little activity to excite the horrid symptoms which constituted and characterized the distemper he had so lately witnessed. Yet he knew, and there was no need of any new experiment to prove it, that this very azote did not always evaporate with caloric in the form of air; but in higher degrees of heat than that of October, when his experiments were made, this *acidifiable basis* frequently connected itself with oxygen, and constituted

a very peculiar and destructive acid. Such an acid poison, he became persuaded, had deprived Mr. Hewson, Dr. Walth, Mr. Jones, and other dissectors, of their lives, by being admitted to a surface denuded of skin. Dr. Latham's fact of the servant poisoned by touching an agnail on his finger with the flesh of a putrid hare which he was skinning, is of the same kind. Immersion of these carcases in strong solutions of alkaline salts, or the mere sprinkling them with pot-ash or soda, would, he thought, have prevented those unpleasant accidents.

In such cases the product formed by the chemical union of azote with oxygen, mingled with more or less of water, and existing in a liquid form, poisoned only when the parts of a living animal were brought into contact with it, as it bespreads the surface which produced it. But Dr. Mitchill was convinced, that, in higher temperatures, when the surface of the earth was heated to 116 degrees, and even to 130 of Fahrenheit's scale, this liquid poison took on occasionally a vaporific or aërial form, and was copious enough sometimes to taint or infect a chamber, a house, a neighbourhood, or even a city. In the former case it injured none but those who meddled with it, in the spots where it was produced; in the latter it rose into the atmosphere, and sallied forth in quest of prey, to distances indefinitely remote.

About this period of the inquiry Dr. Mitchill made an excursion through a part of the State of New York, in consequence of an appointment from the Society for promoting Agriculture, Arts and Manufactures, to explore the natural productions of the country, and especially to determine whether any mines of coal existed in the neighbourhood of Hudson's River. It did not appear that any considerable quantities of that article of fuel were to be found; but it was ascertained, in the course of the expedition, that, in some of the manufactories, where the alkaline salt of burnt-wood is extracted to form the pot-ash and pearl-ash of commerce, there was enough of *oxygenated azote* in the atmosphere to  
combine

combine with a portion of the alkali crystallising about the leech-tubs, and to constitute salt-petre. The labourers at pot-ash works, though much exposed to night air, were seldom visited by the ordinary fevers of the climate.

His attention being thus called to the properties of alkalis, was soon engaged in a more minute investigation of the history of pot-ash, by the following incident. Dr. Mitchill received from the Chamber of Commerce in Glasgow, a letter complaining of the bad quality of certain barrels of pot-ash and pearl-ash exported from New York under the inspector's brand, and proved by the bleacher at Paisley, to whom it had been sold, to possess hardly any qualities for whitening goods. This letter was accompanied with a notorial copy of the proceedings in a suit at law brought by the bleacher at Paisley, plaintiff, against the commission merchant in Glasgow, defendant, for damages on account of having sold him unmerchantable alkali; in which the Court gave judgment for the plaintiff. These papers were submitted to the Chamber of Commerce in New York. In consequence of this, Dr. Mitchill was requested by the president of that body, a short time after, to visit with him the stores of the public inspectors of pot-ash and pearl-ash in the city of New York. Among many other facts which were collected during this visitation, it was related by the inspectors, that, while the labourers in the pot-ash store kept themselves at home and were within the influence of the alkali, the pestilential air of the city had not affected any of them with disease; and Dr. Mitchill discovered afterwards, that if these very labourers exposed themselves to the noxious gas in the air abroad, they sickened and died like other people.

While these things were under consideration, the Legislature of the State assembled. At that time there was considerable conversation throughout the United States concerning the internal and domestic means of defending the country from invasion by a foreign enemy. A man appeared with a project for setting up a manufacture of salt-petre in the  
neigh-

neighbourhood of the city of New York. On this project Dr. Mitchill was consulted. The man's intention was to have petitioned for the privilege of having the dirt and ferapings of the streets as a reward for keeping them clean. And from this mass of nuisance, *whose vapour in the hot season gave the people their yellow fevers*, he intended to extract the nitre. After much consideration of the project it was finally given up, as about that time the Secretary of State reported to Congress that a considerable quantity of that material had been brought to Philadelphia from some part of the western country, and that any quantity required for the public defence might be procured from that quarter.

From a comparison of all the facts which had thus come to his knowledge, Dr. Mitchill found that some of the principles in which he had been instructed, were not so well established as they ought to have been. A number of the darling prejudices of his education were in danger of being overturned. And he, for some time, experienced no small degree of affliction at the thought of rejecting much of what he had learned from books and lectures, concerning *acids* and *alkalis*, as groundless and untenable doctrine.

The fluids, whether liquid or æriform, which *pot-ash* could coerce, and which, as they emane from putrefying bodies, combine with that alkaline salt into nitre, thus appeared to be the very noxious miasmata which vitiated the atmosphere and rendered it sickly and unwholesome, when there was too little alkali or none at all to attract them. These seemed to be evidence enough to convince him, and any body else who would examine the facts as he had done, that some combination of azote with oxygen was the simplest and most common form of poison.

At the same time he was perfectly aware that what he thus called a poison, was what mankind knew under the name of the *nitrous acid*; that *nitre* was called a *great antiseptic*; that the acid was classed among the *mineral acids*, and was reckoned a *great antiseptic too*; with a multitude of say-  
ings

ings of this sort. He therefore apprehended that the old and rigid adherents to these names, and to the modes of thinking associated with them, would scarcely have patience enough to listen to any modernised, or, as they would term it, new-fangled statement of the facts. This difficulty was the more formidable, as it was found necessary eventually to make an innovation upon the French nomenclature itself.

To facilitate his own conceptions of things, rather than to affect novelty or attract proselytes, and also to render his expressions of these things more correct and easy, he proposed what he deemed an allowable amendment to the nomenclature, by expunging *azote*, *azotic*, *nitrous*, *nitric* and their *derivatives*, and taking *septon* for the radical term, with *septous*, *septic*, &c. as the preferable epithets. He conceived he had a right to make use of a nomenclature of his own, if he pleased; while others, if they preferred it, were at liberty to adhere to the old one.

[To be concluded in next Number.]

VII. *On the Use of Calcareous Stones in the Manufacturing of Crude Iron.* By Mr. DAVID MUSHET of the Clyde Iron Works. Communicated by the Author.

THE tenacious lava which is formed when iron ores or iron stones are fused without the addition of any other substance, first led to the application of calcareous earths, in various proportions; that a fluid sufficiently thin and divided might be formed, and the iron disengaged from its vitrid connections, precipitated to the bottom of the furnace. If the nature and mixture of the ore are well understood, the quantity of lime necessary to restore a just equilibrium of proportion in the lava will be readily attained; the metal, no longer incorporated with or suspended in the mass, will become completely revived, and flow from the furnace sufficiently purified from its earthy mixtures.

Before

Before this principle was understood and generally acted upon, the result in iron, from a given quantity of ore, must have been very uncertain, and its real value in the smelting furnace falsely appreciated: even at this advanced period of improvement, and attainment of scientific knowledge, it is much to be doubted if the principle of application of calcareous earths, in the blast furnace, is radically understood.

If an almost total want of knowledge concerning the nature, proportions, and variety of the earths united to the ores, prevail at the various manufactories of iron in Britain, we are not to wonder that the application of lime-stone is subject to great error, and productive of hurtful consequences.

In the smelting process the three great springs of action and government in the manufacture ought to be—a complete revival of all the metal contained in the ore—to confer value upon it, by reviving it saturated with a sufficient quantity of carbon—and to use every endeavour to increase the quantity: still, however, keeping in eye the produce of iron from the ore, and its quality; both of which may be easily impaired by too much eagerness after quantity.

To deprive an ore of its iron, so that no portion of it shall escape in the scoria unrevived, two things are indispensable: 1. The metal contained in the ore must be presented to a portion of fuel sufficient to take up the oxygen from the metal. 2. As this revivification goes on in the manner of a metallic perspiration upon the softened surfaces of the ore, another agent ought to be present to facilitate the separation, by uniting with the earthy parts of the ore; forming a thinly divided lava, no longer capable of retaining the globules of metal, or of preventing the congenial affinity of the carbonic principle from taking full effect for the improvement of the quality of the iron.

Experience has shewn, that an excess of any particular earth may be corrected by applying one opposite in its effects; and that the addition of lime, in various proportions, is found in most cases to answer the desired end: this once understood,

understood, it will be easily comprehended, that as iron stones and ores possess widely different proportions of mixture, their fusion will be productive of vitrid scoriæ, various in their degrees of division and tenacity. This leads to a conclusion, the justice of which cannot be doubted, that since the various mixtures of iron ores are productive of lava, which tends more or less to keep the iron from separation, it becomes a necessary study to obviate the imperfections of such mixtures, and at all times to regulate the proportion of the calcareous earth, from a knowledge of these mixtures and their effects, and not from an implicit reverence to the customs of a senior establishment.

If the various classes of iron stones are fused in contact with charcoal, without the addition of a flux or solvent, the result is, from calcareous iron stone, a larger portion of iron proportioned to the intrinsic richness of the ore, than from argillaceous iron stone; and from the latter, a larger produce of iron, than from an ore whose chief mixture was silex: the scoria produced in the respective operations always demonstrates, from its colour and opacity, the probable quantity of iron which still remains to be taken up.

There are some calcareous iron stones which contain lime almost sufficient to form the necessary quality of scoria, the colour of which, when freed from the metal, possesses a considerable degree of transparency. When a number of these iron stones are used in the blast furnace, a much less quantity of calcareous earths is necessary. It sometimes happens at iron works, whose chief supply is derived from a calcareous field of iron stone, that, by using a great proportion of an individual ore surcharged with lime, the operations of the furnace are obstructed, and consequences entailed fatal to the interest of the manufacturer. From an excess of pure calcareous earth being present in the furnace, the scoria, thick and curdled, becomes attached to the sides and bottom of the furnace; the quantity hourly increases, till it has accumulated to such a degree as to intercept the ascent of the blast,

and the descent of the materials. The source of this evil is justly attributed to the nature of the iron stone; but in place of attempting to obviate its imperfections of mixture, it is either totally rejected, or used in the most sparing quantities: whereas, had the quantity of calcareous earth been proportioned to that contained in the iron stone, the same ore might have been advantageously smelted, and a considerable quantity of lime saved. The same happy effects might also have been produced by combining with the calcareous iron stone, one containing a large proportion of clay or sand; in some situations, where a variety of lime stones are found, the same consequences may be effected by applying one less pure, mixed with a proportion of clay and filex.

A similar excess of clay in the argillaceous genus of iron stones, is fraught with the same fatal effects to the produce in metal from the blast furnace; and many such ores of iron are totally rejected, merely because their improper application was found productive of consequent effects. The fusibility of lime and clay, individually, is much facilitated by the addition of sand; and in all cases where these earths exist to excess in the ores, they ought either to be combined in the blast furnace with siliceous iron stone, or treated with a lime stone containing a considerable portion of sand.

Again, instances occur in the manufacturing of crude iron, where ores sufficiently rich in iron are totally rejected, as being incapable of affording a quality of crude iron for the purpose of melting. It is found that an excess of such iron stone always changes the colour of the scoria, and that a considerable portion of the metal goes to effectuate this change in the state of an oxyde united with the fused earths. These ores are of the most fusible nature, combined with a heavy proportion of filex; but still capable of being treated in such a manner as to afford their iron of a valuable quality. When this mixture is fully ascertained, the fusibility of the iron stone is little impaired, and the quality of the iron mended with an increase of quantity.



From this it will appear evident, that the addition of calcareous earths, in just proportions, will form with most ores a vitrid alloy, thinly divided, and to which the metal has so little affinity, that it becomes abandoned by the former at an early stage of separation, and, being exposed to the combination of the carbon, is beneficially and richly revived. In this operation lime may be considered as introducing into the furnace a considerable quantity of carbonic acid, [it is always used in the raw state] which becomes decomposed in such a manner as to furnish the iron with a small portion of carbonaceous matter. The effects of this extension of principle are however much limited, as the carbon afforded by the decomposition of the carbonic acid can never enable the iron to take up this principle from it in a crude concrete state, capable of constituting fusibility. It may, however, by uniting to it in a neutral state, call it into metallic existence, and enable the carbon afforded by the fuel to distribute its fusible principle over a larger portion of metal. Lime-stone therefore ought never to be considered as a general substitute for fuel in the blast furnace, though in some cases the effects produced by its application are similar. Its influence extends no farther than to correct the unequal mixtures of some ores, and facilitate their separation and carbonation; an improper application of its kind or quantity may be productive of evils of as great magnitude as those it was meant to remove. In no case where a just proportion of ores and mixtures exist in the furnace, and where the result from a real scarcity of fuel is oxygenated iron, can the addition of lime confer carbonation to the metal.

These facts render the application of lime-stone a matter of attention, and not of chance, depending on an accurate knowledge of the component parts of the ores and their effects, and not on certain portions being customary at works of similar establishment. When a scarcity of lime exists in the blast furnace, and a superior quantity of clay  
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and filix is combined with the iron stones, the lava will flow from the furnace comparatively cold, tenacious, and of a brown or pale dirty green colour, containing iron: when the mixture is just, the colour of the scoria is pure white, enamelled with a variety of blue shades, waving, circular, or formed in straight delicate lines, arising from a peculiar existing modification of a minute portion of the metal. Should lime be added in excess, the quality of the iron will not be improved, but the quantity considerably diminished. This loss takes place in two ways; when the iron is oxygenated, the presence of an extra quantity of fused earths facilitates the oxydation of the metal, whenever it comes into contact with atmospheric air \*. The strong current of air from the discharging pipe affords ample opportunity for this oxydation; the small globules of metal deflagrate and become combined with a great portion of oxygen; the want of carbon in the furnace prevents any part of the oxygen from being again removed; the oxydated iron incorporates with

\* As I have frequent occasion to use the two verbs, to oxygenate, and to oxydate, I shall express the precise meaning I attach to two words which are sometimes indiscriminately used, and to which it has been thought that M. Lavoisier had affixed no separate or distinct meaning. I have used oxygenate to express the progressive combination of oxygen with the metal, without, however, destroying its metallic fracture, or exhibiting internally the smallest appearance of an oxyde. Oxydation, on the other hand, I have always used to express the final consequence of the combination of oxygen with iron, and the complete change from a metallic state, to that of a detached friable oxyde. For example, crude iron run from the furnace, of a white fracture, is said to be oxygenated. In cooling, being exposed to atmospheric air, it acquires a considerable quantity of blueish oxyde; its surface may then justly be said to be oxydated. It is the same with malleable iron and steel; each of these suffer in quality from the affinity oxygen has to combine with them, at a high temperature, before the least diminution of metallic fracture takes place; and in that state I have always considered them as oxygenated. When, however, this was past, and the combination of oxygen had destroyed every property of metal, I have considered this only as a state of oxydation.

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the scoria floating upon the surface of the precipitated metal, changes its colour, and in issuing from the furnace conveys a complete change of form and deposition.

Should it, however, happen that an extra quantity of lime is added when the iron is already richly carbonated, then the metal lost is no longer in the state of a fused oxyde incorporated with the scoria, but in small metallic globules, completely enveloped, unable to penetrate the curdled mass and find their way to the bottom of the furnace. This curious phenomenon arises from the peculiar nature of fused calcareous earth, which, while it possesses no great degree of tenacity as a fluid, yet forms a consistency through which iron with all its superior density is not able to penetrate: when cold, such scoriæ have no appearance of vitrification, but are of a straw colour, rough fracture, and very ponderous. I have some specimens of this scoria, obtained from the blast furnace, with triple strata of regularly deposited globules of super-carbonated crude iron, from half an inch to the smallest diameter.

The strict analogy existing betwixt lime stones and ores, in the variety and proportions of the earths combined with each, renders the investigation of both equally necessary, and requisite to be performed in connection with each other.

There are advantages to be derived from a thorough knowledge of the component parts of iron stones, which may not at first sight strike the manufacturer: where a variety of situations offer, this knowledge will direct him to an establishment where the iron stones are of a nature most likely to suit his views. Where melting pig iron for sale is the chief object, calcareous iron stones mixed with flint and nearly destitute of clay possess the greatest advantages. Iron made from this class of ores never possesses any great degree of strength; this, however, in the casting business in general, is reckoned its greatest property; it becomes fused with less fuel, less waste of metal, and the articles made from it exceed those made from stronger iron, in the smoothness of their surface and in the solidity of their parts.

Analogous to these facts, we daily see the superiority of situation evinced, and *cæteris paribus* larger products in iron obtained from a general use of calcareous iron stones than any other. This superiority is derived from the congenial mixture of the ore, combined with a large proportion of lime, which facilitates the carbonation of the metal; and united with a just portion of sand to constitute fusibility, the same column of blast will, in the same time, reduce a much greater quantity of it, affording the iron at the same time sufficiently carbonated, than of other iron stones differently combined.

On the other hand, where the intention of the manufacturer is to fabricate a quality of iron possessed of every requisite for converting into good malleable iron, calcareous iron stones, in quantity, ought to be avoided, and those of the argillaceous and siliceous classes substituted. Those of equalised mixtures of earth, combined with pure argillaceous ores, afford the strongest quality of crude iron; capable of being melted to advantage for the construction of heavy pieces of machinery, or used for the purposes of the forge. In the use of these classes, however, great strength and quantity will be frequently found at variance, when the quality of the metal is wished to be preserved carbonated: this also arises from the nature of the mixture in the iron stone; clay in quantity, united with various proportions of lime, forms an alloy, more difficult to fuse than where lime in quantity is united with various proportions of flux.

Where nature has bestowed mixtures productive of every quality of crude iron, the proper arrangement of ores would become simple and easy; just combinations of mixture supersede the necessity of changing the quality of the lime stone added for a flux, or of having recourse to various qualities of it, in order to assist or correct the deficiency of the native mixture. Wherever the ores are of a structure thus deficient, it then becomes the province of the manufacturer to ascertain the mixture of the individual ores which compose his supply, and

and to restore that equilibrium of parts by the proper application of superadded earths, which experiment and observation have proved to determine a certain quality of iron.

Those works whose situation enables them to draw their supply from fields of iron stone, impressed with all the various characters of mixture, possess many advantages which those more insulated are frequently deprived of. With equal ease ought the manufacturer to be able in these cases to fabricate with certainty a quality of iron capable of forming to advantage the most minute piece of casting, or the heaviest piece of ordnance; at pleasure he might form a quality fit for the forge, or of value in the pig iron market. In short, where such variety of ores exist, iron of every quality, comprising fusibility and strength, may at pleasure be manufactured, suited to the many and various wants of a foundry and forge.

Failing, however, of this universal assortment of iron stone, nature has in many places kindly formed a competent substitute, in the great variety and quantity of lime stone which are found within easy reach of the blast furnace, possessing component parts widely different from each other; from a state of the greatest purity, to the heaviest alloy of heterogeneous mixtures; sometimes so far debased as not to be justly appreciated when ranked under the class of lime-stones.

A want of analytical knowledge in the manufacturer may often lead to the purchase of such qualities as may be superfluous, from the variety of his ores, or which are diametrically opposite in quality to those which ought to have been applied. I shall here annex the analysis of the principal lime-stones used at the Clyde Iron Works, which from their superior situation, having easy access to the eastern or western oceans, can at pleasure draw their supplies from a greater number of quarters than any other work in Britain.

The silence of provincial historians respecting the constituent parts of various limes is a second inducement to furnish such a table, which may enable the husbandman to de-

cide with a just preference upon that quality most proper for the culture of his grounds. I found chalk to contain carbonic acid and water

	-	-	37'3
Silex and a minute portion of clay	-	-	1'045
Lime	-	-	61'655

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100 parts.

**Irish white lime-stone.**—This beautiful calcareous stone is found in various places on the coast of Ireland. It greatly resembles chalk, and differs only from it in its hardness, which it derives from a greater quantity of water of crystallisation; it abounds with fine specimens of dog teeth and coxcomb crystals; contains a considerable quantity of flint in rounded and ovular forms, with very perfect specimens of belemnites. I found this lime-stone to contain water of crystallisation and carbonic acid

	-	-	44'5
Silex and a minute portion of clay	-	-	3'7
Lime	-	-	51'8

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100 parts.

**Irish blue lime-stone from Larn.**—This stone is of a dark blue colour, smooth fracture, and studded with small shining spiculæ; it contains no mixture, or form foreign to itself. It contains water of crystallisation and carbonic acid

	-	-	37'14
Silex	-	-	9'43
Lime	-	-	53'43

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100 parts.

**Arran lime-stone, from the Island of Arran.**—This is a reddish-coloured lime-stone, abounding with such an immense quantity of shells, that the whole stratum, which measures 60 feet in thickness, appears to have been formed of shells connected by means of a calcareous cement much less pure; these are all univalve, uncommonly large, some of them 6 or 8 inches in diameter, and form the purest lime. In calcination this stone loses its colour, and becomes as white as snow; perhaps a small portion of iron dissolved in the

the carbonic acid communicates to it the red colour. I found it compounded as follows: water of crystallisation and carbonic acid

				39.57
Silex	-	-	-	2.58
Clay	-	-	-	1.12
Lime	-	-	-	56.73

100 parts.

Cambletown lime-stone on the Argyle coast.—This is a very dark blueish-coloured lime-stone, of a large granulated metallic fracture, hard and refractory; it presents no specimens of marine remains, but abounds with a common calcareous spar, in which regular form is perceptible; when calcined it retains a delicate tinge of blue colour. I found the component parts of this stone to be, water of crystallisation and carbonic acid

				41.42
Clay	-	-	-	2.407
Silex	-	-	-	2.92
Lime	-	-	-	53.253

100 parts.

Thornton lime-stone, parish of Killbryde.—This is a light blueish clay-coloured lime-stone, susceptible of a fine polish, and abounding with a great variety of marine shells of various sizes; the schistus contains an infinite number of the remains of small fishes, shells, &c. It yielded water and carbonic acid

				43.91
Silex	-	-	-	4.67
Clay	-	-	-	5
Lime	-	-	-	50.92

100 parts.

Cresbasket lime-stone, same parish.—This stone greatly resembles the former, but possesses a greater variety of quality, sometimes inferior, but contains very few shells or marine

remains. The following are its component parts: water of crystallisation and carbonic acid

	-	-	42.9
Clay, with a small tinge of iron	-	-	3.3
Silex	-	-	2.7
Lime	-	-	51.1

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100 parts.

East-Wood lime-stone, from parish of the same name.—This is a sharp splinty lime-stone, of an even fracture, but abounding with small spiculæ of silex; when exposed to wet for some time its surface becomes oxydated like an iron stone. It contains a great number of univalve and bivalve shells, and marine decomposition of various kinds. It possesses not the property of falling into lime, unless watered when at a red heat; it then forms a coarse pulverulent earth; of a greyish brown colour. It contains water and carbonic acid 27.42

Clay	-	-	-	3.73
Iron	-	-	-	5.83
Silex	-	-	-	36.66
Lime	-	-	-	26.36

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100 parts.

Lime-stone from the neighbourhood of Kirkintulloch.—The appearance of this stone is more favourable than the former, though of the same inferior cast; it contains no substances foreign to itself. Its constituent parts are, water of crystallisation and carbonic acid

	-	-	87.3
Clay	-	-	12.5
Iron	-	-	3.135
Silex	-	-	8.36
Lime	-	-	38.705

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100 parts.

Kylfyth lime-stone.—This stone is of a dark blue colour, smooth fracture, and sounds like metal when struck upon. It abounds with the finest specimens of pure calcareous spars, frequently



frequently resolved into transparent crystals: the chafins where these are found are sometimes enriched with beautiful prismatic pyritical crystals of a flat scaly form. The component parts of this lime-stone are as follow: Water of crystallisation and carbonic acid . . . . . 39.52

Silex . . . . . 5.73

Lime . . . . . 54.75

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100 parts.

From what has been stated, we are led to inquire into the cause which produces effects so widely different in the fusibility and strength of crude iron. The existence of calcareous, argillaceous and siliceous earths in the blast furnace, has been mentioned as effecting these changes; and it has been also noticed that, under certain mixtures of these, determinate qualities of crude iron are produced.

If a predominancy of calcareous earth is used as the standard for comparison, with a local proportion of fuel, we find that in proportion as the lime is diminished in quantity, and clay added through the medium of the ore, the quantity of metal produced will be less, but its strength greatly increased; and if the argillaceous ores are pure, the carbonation of the metal will be little altered. Should siliceous mixtures be applied in place of argillaceous, we find that, in proportion as lime decreases, and the quantity of sand in the furnace is augmented, the quality of the iron becomes less carbonated, less fusible, and its small portion of strength greatly impaired: sand through the medium of the ore may be added, so as to render the iron as brittle as glass, and as white in the fracture as silver.

Again, let a predominancy of siliceous earths in the blast furnace be the standard for comparison; in proportion as these are diminished by the addition of argillaceous ores, the metal will pass from the state of extreme brittleness and oxygenation, to a state comparatively stronger and containing more carbon. Should calcareous iron stones be added, their addition will

immediately correct the pernicious effects of the *silice*, and facilitate the carbonation of the metal; but will not confer any great degree of additional strength. Lime may be added to such excess as to render the continuity of the particles of iron so small as to be easily divided into granulated masses, forming a true *plumbago*.

From a consideration of these results, we are led to attribute to calcareous earths the property of facilitating the carbonation of the metal where an improper combination exists; which property is derived from the carbon of the acid with which they are neutralised. To argillaceous ores we ascribe strength, without having the tendency of destroying the carbon, merely because these ores contain a very considerable portion of lime; their union counteracts the natural fusibility imposed by lime, and at the same time is productive of strength. Siliceous iron stones are viewed less favourably, being nearly destitute of lime; the iron in the furnace varies in principle from the development of its mixtures, and only depends upon the quantity of carbon furnished by the fuel to become saturated with a sufficiency to constitute fusibility.

The exclusive predominancy of lime and *silice* apart tends in the smelting process to reduce crude iron to its two greatest extremes of quality, carbonation and oxygenation; both of which states are equally destitute of strength. Clay acts as the restorer of these disproportions, and by a happy combination produces the medium of the two extremes, which is strength and undiminished quality.

Were siliceous iron stones universally combined with a larger portion of oxygen than the other classes, another clue would be furnished to explain why siliceous mixtures were less congenial to the existence of carbon in the blast furnace, than those of lime and clay; and why the metal obtained from the former is always more oxygenated with the same portion of fuel than that obtained from the latter. Although I am convinced that this frequently is the case, yet, as I have  
not

not been able to assume an extra fixation of oxygen in siliceous iron stones as an universal principle, I would not wish to apply it, in any great degree, to the solution of the present theory, seeing the causes already advanced are sufficient for an explanation of the whole phenomenon.

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VIII. *Account of Bugs found in hollow Trees, with Observations on that Phenomenon.* By S. OEDMAN \*.

IT is a well known prejudice among the country people in Sweden, that they believe the house bug takes up its residence in the common yellow wall lichen, which grows under the juniper bushes, &c.; but, as far as I have been able to learn, no entomologist ever yet found the real house bug in standing trees, and therefore the following new observation seems to be worthy of attention. Last August some workmen, who were cutting wood on an island in Nämndö Sound, sat down under a hollow alder tree in order to eat their dinner. One of them having accidentally made a noise near the trunk, aroused a bat (*vesp. murinus*), which was immediately seen to fly out from a hole in the side of it. Being desirous to know whether there were any more animals of the same kind in the trunk, these wood-cutters gave it a violent stroke, and a mass was heard to drop, which one of them pulled out with his hand, and found to consist merely of bugs. It is impossible they could be deceived in regard to vermin so well known; and what rendered the circumstance still more certain, was, that they found under the wings of the bat, real bugs, which had taken up their abode there, together with the usual insects that infest these animals. The whole quantity of bugs amounted to about three quarts. M. Blix, who was at great pains to examine this phenomenon more narrowly, found in the bottom of the

\* From New Transactions of the Academy of Sciences at Stockholm, vol. x.

hollow tree two concave places filled with straw and soft earth, in which the bats probably kept their young; for the old ones when they sleep generally suspend themselves by the hooks of their wings. Some time after, M. Blix having heard that a bat had been seen to fly into a hollow tree on the island where he resided, repaired to the place, and drove from the tree thirty-seven bats. It accidentally came into his head to examine with a stick the roof of their dwelling; and when he drew out the stick he observed the end of it covered with bugs. He made no farther examination till a few days before Christmas, when the tree was felled; but at this time neither bats nor bugs were to be seen. He, however, discovered that this tree had lodged guests of various descriptions; for the lower part had been inhabited by bats; the roof of the cavity by bugs; the middle by nut-peckers, and the top of the tree by a squirrel. It is not altogether improbable that the bugs had been carried thither from some habitation by the bats, especially as they were found, in the first case, on an island totally separated from the continent, and on which there was not a single house. It is more difficult to explain how such a multitude of bugs could find nourishment on two or three dozen of bats; but instances have been known of stone buildings infested with such vermin, remaining above a year uninhabited, and yet these insects, so far from being extirpated, have not even been lessened. We can scarcely then give any other explanation, than by supposing that bugs eat each other when they have no other nourishment; and that the loss thence occasioned is supplied by their great multiplication. The cause why no bugs were found when the last mentioned tree was felled, may have been, that they were destroyed by the birds. In confirmation of the above, M. Carlson adds the following circumstance: "In the year 1777," says he, "I found an old rotten stake, that had been used for a support in a hedge, which was so covered with house bugs that it resembled an ant-hill; it lay at a great distance from either houses or gardens,

dens. I inquired whether this stake had, at any time, formed part of a building, or been near one; but I was assured by a peasant that he had cut it down not far from the spot, and that it had never been employed for any other purpose. As this stake was not hollow, and could afford no shelter to bats, it does not appear how these bugs could be conveyed to it from a house. There is reason to conjecture, rather, that these insects live and propagate even in timber. That they are able to endure the winter cold is beyond all doubt. I exposed a piece of furniture to the open air for three years, and every summer bugs were observed upon it in great abundance.

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IX. *Observations on Animal Electricity; being the Substance of two Letters from A. VOLTA to Professor GREN\*.*

**I**F a tin basin be filled with soap-suds, lime-water, or a strong ley, which is still better, and if you then lay hold of the basin with both your hands, having first moistened them with pure water, and apply the tip of your tongue to the fluid in the basin, you will immediately be sensible of an acid taste upon your tongue, which is in contact with the alkaline liquor. This taste is very perceptible, and, for the moment, pretty strong; but it is changed afterwards into a different one, less acid but more saline and pungent, until it at last becomes alkaline and sharp in proportion as the fluid acts more upon the tongue, and as the activity of its peculiar taste and its chemical power, more called forth, produce a greater effect in regard to the sensation of acidity occasioned by the stream of the electric fluid, which, by a continued circulation, passes from the tin to the alkaline liquor, thence to the tongue, then through the person to the water, and thence to the tin again. I explain the phenomenon in this

\* From *Neues Journal der Physik*, vol. iii. p. 4, and vol. iv. p. 1.

manner, according to my principles; and indeed it cannot be explained in any other, as every thing tends to confirm my assertion, and to prove it in various ways. The contact of different conductors, particularly the metallic, including pyrites and other minerals as well as charcoal, which I call dry conductors, or of the *first class*, with moist conductors, or conductors of the *second class*, agitates or disturbs the electric fluid, or gives it a certain impulse. Do not ask in what manner: it is enough that it is a principle, and a general principle. This impulse, whether produced by attraction or any other force, is different or unlike, both in regard to the different metals and to the different moist conductors, so that the direction, or at least the power, with which the electric fluid is impelled or excited, is different when the conductor A is applied to the conductor B, and to another C. In a perfect circle of conductors, where either one of the second class is placed between two different from each other of the first class, or, contrariwise, one of the first class is placed between two of the second class different from each other, an electric stream is occasioned by the predominating force either to the right or to the left—a circulation of this fluid, which ceases only when the circle is broken, and which is renewed when the circle is again rendered complete. This method of connecting the different conductors will be more readily comprehended by turning to the figures, (plate I,) where the capital letters denote the different conductors or exciters (*moteurs*) of the first class, and the small letters those of the second class. Fig. 1 and 2 express the two cases above mentioned.

I consider it as almost superfluous to observe, that when the circle consists merely of two kinds of conductors, however different or however numerous the pieces may be of which each consists (as fig. 3, 4, 5 and 6), two equal powers are opposed to each other; that is, the electric fluid is impelled with equal force in two different directions, and consequently

no stream can be formed from right to left, or contrariwise, capable of exciting convulsive movements.

There are other cases, however, and other modes of combination, where the powers are equally in equilibrium, and where no current of the electric fluid can take place; or, at least, none of such a force as to make an impression on the tenderest nerves, or to excite any convulsive movement in the best prepared frog that may be placed in the circle, notwithstanding the intervention of two or more different kinds of metals. This is the case when each of these metals is placed between two moist conductors, or of the second class, and which are very nearly of the same kind, as fig. 7; or when, in a circle of three pieces, two of them of the same metal, and one of a different metal, are so connected, that the latter is immediately between the other two, as fig. 8.

When one of the ends of the middle piece of metal A is immediately applied to one of the two pieces Z, but, instead of immediately touching with the other end, the other piece Z touches an intermediate conductor of the second class, either great or small, either a drop of water, a piece of raw or boiled flesh, or of sponge not moist, paste of meal, jelly, soap, cheese, or the white of an egg boiled to hardness, in this new combination, represented by fig. 9, (where a conductor of the second class *m* is between two of the first class, A and Z) the powers are no longer opposed to each other; and this is sufficient to determine an electric stream. When *g*, therefore, in fig. 9, is a prepared frog, it will always be violently agitated as often as this circle is made complete.

It may be readily perceived that the two last experiments, represented by fig. 8 and 9, coincide with those announced by M. Humboldt, where a drop of water, a small bit of fresh meat, or a very thin stratum of any fluid, performs the whole wonder. When another drop of water, or any other aqueous conductor, is applied between the other end of A and the other corresponding piece Z (as shewn fig. 10), each piece of metal is insulated, as I shall express it, between two

aqueous

aqueous conductors : but then the powers from right to left, and from left to right, are again completely opposed to each other ; consequently the electric stream is impeded, and the frog remains without any movement. It is, therefore, absolutely necessary that two different metals or conductors of the first class should be in immediate contact with each other, on the one side, while with their opposite ends they touch conductors of the second class.

We might consider this mutual contact of two different metals as the immediate cause which puts the electric fluid in motion, instead of ascribing that power to the contact of the two metals with the moist conductors. Thus, for example, in fig. 1, instead of admitting two different actions, at least, in regard to the magnitude of the power, one where A comes in contact with *a*, and another where Z comes in contact with *a* also, by which an electric current arises in the direction from Z to A, we might suppose only one action at the point where A comes in contact with Z, which impells the fluid in that direction. In both suppositions the result, as may be easily seen, is the same. But though I have reasons for adopting the first as true rather than the second, yet the latter represents the proposition with more simplicity, and it may be convenient to adhere to it in the explanation, as it affords a readier view of it. We may then say, that in the cases of fig. 3, 4, 5, 6, 7 and 10, no effect will be produced, because here there is no mutual contact of different metals : that the effect also, according to fig. 8, will be null, because A, on two opposite sides, is in contact with Z and Z, and the actions therefore are in equilibrium ; and lastly, that an electric current will be occasioned in fig. 9, by the action which arises from the contact of A and Z, and which is counteracted by no other contact of the like kind.

Having seen the result of employing three pieces of metal, or conductors of the first class, viz. two of one kind and one of a different, when combined sometimes in one way and sometimes in another with conductors of the second class,



we shall now try what will be the result, according to my principles, with four pieces of metal, two of which are of one kind; for example, zinc, when connected with moist conductors of different kinds.

I shall first observe, that when they are connected in a circle, as at fig. 11, the powers which endeavour to put the electric fluid in a streaming movement will be opposed to each other, and in perfect equilibrium, and that consequently no movement can take place in the frog, here supposed to be the moist conductor *a* or a part of it, however irritable and well prepared it may be; and if the experiment be made with accuracy and the necessary precaution, so that the metals, in particular, be very clean and dry at the points of contact, it will perfectly confirm what I have above said: the frog will experience no agitation, no convulsive movement.

These movements, on the other hand, took place, as might be foreseen from my principles, as often as I omitted one of the middle pieces, or changed the order.

The conductors of the second class, which in all the figures are denoted by small letters, may be cups with water, in which the ends of the pieces of metal denoted by the large letters are immersed; or sponges or other bodies which have imbibed aqueous moisture. They may be either large or small; and may consist of one or more pieces, provided they be in proper contact: they may also be persons, if their skin be moistened at the places of contact, &c. By the last method the experiments will be very beautiful and incessant, when the circle consists of three or more persons (I have formed it frequently of ten and even more), of two or more frogs properly prepared, and of four pieces of metal, two of silver and two of iron, tin, and particularly zinc. The change of effect, when you change the connection, is striking.

Let the position be as represented in fig. 12, where *g* is the prepared frog, which the two persons *p, p*, hold in their hands, one on the one side by the feet, and the other on the opposite by the rump. *Z, Z* are two plates of zinc, which

are

are held also by these persons, and A, A, two pieces of silver, which are held by a third person, denoted also by *p*. It must not be forgotten that the hands should be very moist, as the dry skin is not a conductor sufficiently strong. As in this chain the actions of the electric exciters are opposed to each other and in exact equilibrium, as may be readily perceived, no convulsion or agitation in the frog will take place.

Now, let one of the metallic pieces A, Z, which stand between the two persons *p*, *p*, or between any other moist conductors, be left in combination as it is; and let the position of the two other metallic pieces A, Z, be reversed, by converting fig. 12 into fig. 13 (so that the actions, instead of being contrary, will act together to impel the electric fluid to one side or to produce the same current); or introduce between A and Z another person, or any other conductor of the second class, so that the chain be formed as in fig. 14; or take away one of the pieces A, Z, in fig. 12, and make the chain like those of fig. 15 and 17; or, in the last place, remove the whole two pieces A, Z, either in the one or the other side, as represented fig. 17 (by which means it will correspond with fig. 1, as the whole chain *p*, *g*, *p*, *p*, may be considered as a single moist conductor of the second class); in all these combinations, which are represented by fig. 13, 14, 15, 16, and 17, the actions arising from the metallic contacts are no longer contrary to each other, or in equilibrium, as they were in fig. 12; consequently an electric stream is produced, and the frog *g*, which I suppose to be properly prepared, and which forms a part of the chain, will be violently agitated as often as the circle, when broken at any one place, particularly between metal and metal, is again restored.

In regard to the experiment where a moist conductor, or one of the second class, is to be introduced between the two pieces A, Z (fig. 14), that is, between two different metals, a drop of water, or a small bit of moistened sponge, or a thin stratum of any fluid, soap, or any other viscous matter, will be quite sufficient, as I have already observed respecting fig. 9.

This

This surprising experiment I generally make in such a manner, that, instead of the piece of metal, I employ a cup or spoon filled with water, and then cause the person who holds the perfectly dry and pure stick of tin to touch with that stick sometimes the perfectly dry sides of the spoon or cup, and sometimes the water contained in them. It is wonderful to see, that as by the latter method the violent agitation of the frog never ceases, the first method, which corresponds with fig. 12, does not produce the least irritation; unless by accident there be a small drop of water, or a thin stratum of moisture, at the place of contact, by which the case represented fig. 14 would be restored. This may serve to shew with what care and attention the experiment must be made, in order to guard against error or deception, which might so easily arise, and every where exhibit anomalies.

When I introduce water or any other moist body, great or small, not merely between one pair of metallic pieces A, Z, as fig. 14, but between two pairs, as represented fig. 18, each piece of metal is between like moist conductors, and by these means all the actions are again rendered contrary or brought into equilibrium; or, according to the other mode of viewing the matter, there is no longer any action, for want of the mutual contact of two different metals, which, as we have seen, is certainly necessary to excite an electric current; and it is always found that the frog experiences no agitation.

I shall not enlarge farther on these combinations, which may be varied ad infinitum with a greater number of metallic pieces, and by which one may be enabled to foretel the phenomena which, according to my principles, will always be found to take place. It will be sufficient, for the present, to draw this conclusion, that in a circle consisting merely of two conductors, however different they may be, their mutual contact can produce no electric stream sufficient to excite sensibility or muscular movement; and that, on the contrary, this effect infallibly follows as often as the chain is

formed of three conductors, one of one class, and two different from each other of another class, which come into mutual contact with each other, and that this effect will be stronger the greater the difference is between the latter; that in other cases, where there are more than three different conductors, the effect either is not produced or will be produced in different degrees, according as the forces, called forth by the different combinations, which will be expanded at each heterogeneous contact, and which are often in opposition and endeavour to impel the electric fluid in opposite directions, are perfectly in equilibrium with each other, (which must be a very rare case) or when the sum of those which exert themselves in one direction is more or less exceeded by the sum of those which act in another direction.

I shall here however leave the two complex combinations, and return to the simple cases, those with three different conductors, represented by fig. 1, which are more demonstrative; or, in other words, those with two different metals or conductors of the first class which are in contact with each other, and are applied on the other side to moist conductors or conductors of the second class. This method has been commonly employed since Galvani's discovery, and is in exact proportion with the diversity of metals on which I consider the whole phenomena to depend.

The other method of combination, which is expressed by fig. 2, or that of a metal placed between two different moist conductors, for example, between water on the one side, and an aqueous, saponaceous, or saline fluid on the other, I discovered in the autumn of 1794; and though since that period I have repeated the much varied experiments of different persons, both foreigners and others, among which was that of M. Humboldt, and though I wrote to several correspondents respecting it, that light has not yet been thrown on this new phenomenon which it seems to deserve.

The singular circumstance before mentioned, in regard to the acid taste when the tongue is brought into contact with

An alkaline liquid, belongs, as you may perceive, to this second method of exciting the electric fluid and putting it in circulation (if the tin vessel be touched on the outside by the hand moistened with water, and on the inside by the alkaline liquor), and shews that this current is no less strong and active than that excited by the first method, viz. by employing two sufficiently well chosen metals, such as lead and copper, iron and silver, zinc and tin. I must here observe, that though with tin alone, placed between water and an alkaline liquor, you obtain nearly the effect which is produced by two of the most different metals, as silver and zinc, combined with any conductor whatever of the second class; you can obtain the same, and even in a higher degree, with iron alone or silver alone, when the iron is introduced between water on the one side and nitrous acid on the other, or when the silver is applied between water and a solution of sulphure of pot-ash.

If you take a frog, the head of which has been cut off, and which has been deprived of all life by thrusting a needle into the spinal marrow, and immerse it, without skinning it, taking out the bowels, or any other preparation, into two glasses of water, the rump into one, and the leg into the other as usual, it will be strongly agitated and violently convulsed when you connect the water in both glasses by a bow formed of two very different metals, such as silver and tin or lead, or, what is better, silver and zinc; but this will by no means be the case when the two metals are less different in regard to their powers, such as gold and silver, silver and copper, copper and iron, tin and lead. But what is more, the effect will be fully produced on this so little prepared frog when you immerse in one of the two glasses the end of a bow merely of tin or zinc, and into the other glass the other end of this bow which has been rubbed over with a little alkali. You may perform the experiment still better with an iron bow, one end of which has been covered with a

drop or thin coating of nitrous acid; and beyond all expectation, when you take a silver bow having a little sulphure of pot-ash adhering to the end of it.

Fig. 19 represents the form of this experiment, where *g* is the frog, *a, a* the two glasses with water, *A* the bow formed of one single metal, and *m* the drop or a thin stratum of a mucous, saline, &c. fluid with which the bow has been rubbed over, and which on this side is between the metal and the water.

[To be continued.]

*X. Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth. By M. DE SAUSSURE\*.*

[Continued from page 299 of Vol. III.]

CHAP. XV.

*Observations to be made on primitive Mountains.*

1. **W**HETHER there be any exception to the generally received opinion, that, in primitive mountains, no vestiges are discovered of organised bodies.

2. Whether it be true that in these mountains no indications are found of bitumen or marine salt.

3. To endeavour to determine the respective ages of the different kinds of primitive mountains; both compound, such as granite, porphyry, gneiss; and simple, as slate, serpentine, and primitive calcareous.

4. Whether, in particular, it be certain that granite is the most ancient stone of all those which form the outer crust of our globe, so that it is never found placed above (*superposé*) any other kind of stone.

\* From *Journal des Mines*, No. XX.

5. Whether

5. Whether the large mountains composed of granite in one mass, even the best characterised, do not give certain indications of stratification or divisions by strata, though less regular than those of schistous mountains.

6. Whether in the bases of granite mountains the manifestation of strata be not hurt by the number of fissures, or spontaneous and irregular divisions.

7. Whether, even in the separate blocks of granite, an attentive eye does not discover some veins of mica, which affect the same direction, and such veins as induce the workmen, who wish to make mill-stones or other works more extensive in one direction than another, to prefer attacking the stone in a determined direction.

8. Whether the indications of the stratification are not observed in the interior part of granite mountains, as well as near their surface.

8. A. Whether among the granites in a mass, and those decidedly veined, there are not found such intermediary shades that it is difficult to mark the line of separation.

9. To determine the distinguishing characters of granites of modern formation.

11. To ascertain the truth of the assertion of the Pliny of France, that in proportion as people dig into a mountain, the summit and sides of which consist of granite, the granites, instead of being found more solid and more beautiful the farther they advance, change, on the contrary, below a certain depth, lose themselves, and at last vanish by gradually assuming the coarse (*brute*) nature of the live quartz rock\*.

12. Whether it be true that each primitive mountain is generally composed of one single stone, and of the same nature.

13. To examine whether there be found on the primitive mountains, at great heights, the scattered wrecks of secondary mountains. For my part, I never found any.

14. Whether primitive calcareous stone be found always

\* *Mineraux*, p. 105.

with a granulated fracture, or the form of a saline marble, and never under a compact form.

15. Ought the porphyric schist of Werner, or the *porphyre schisteux à pâte* of primitive petro-felix, to be considered as primitive or secondary? The same question in regard to the *mandelstein* or amygdaloid.

16. Is it fully ascertained, as I thought I observed in the Alps, and M. de Fichtel in the Carpathian mountains, that there exists pudding-stone or free-stone, if not primitive, at least of a formation anterior to that of all the other secondary stones?

17. Were the granites in a mass first deposited, because they were less soluble? and did they crystallise after the quantity or dissolving force of the waters began to diminish? and was it for a contrary reason that the gneiss, mica and magnesian stones crystallised later?

#### CHAP. XVI.

##### *Observations to be made on Transitions.*

1. To observe the intermediary genera and species of fossils, between one genus or one species of fossil, and the genera and species which have the greatest resemblance to them.

2. To observe, above all, the transitions through which nature has passed, when, having produced one genus or one order of mountains, she began to produce a different genus or order; for there is no change of order which has not been the effect of a revolution; and it is in the transitions that traces of these revolutions are to be found.

3. Thus we often see strata of free-stone or pudding-stone interposed between the primitive and secondary mountains; *breches* are seen to form the most elevated stratum, and consequently the newest of some calcareous mountains. We must study then the nature, dimensions and position of these remarkable strata.

4. Having



4. Having found these transitions, or any others, in some mountains, if they are not then found in other mountains, you must examine whether their absence does not arise from their having been destroyed; vestiges of them are to be sought for; and if it appears that they never existed, you must endeavour to discover, in the nature and position of the mountains, what may have been the cause of their absence\*.

[To be continued.]

XI. *Observations on the Manufacture of the Acetite of Copper or Verdigrise, Verdet, &c.* By J. A. CHAPTAL.†

THE acetite of copper is one of the preparations of that metal most frequently used in the arts. It is not only one of the principal resources of painting, but upon many occasions is employed with great advantage in dyeing. Almost all the oxydes of copper obtained by the action of saline substances have a blue colour, more or less inclining to green, and almost all the neutral salts corrode the metal, and produce that oxyde which is called verdigrise. It is sufficient to bring them into contact with the copper, or to immerse the metallic plates in a saline solution, and afterwards to expose them to the air to dry.

Those acids which oxydate the copper by their decomposition, produce an effect like that of neutral salts. The oxyde is of a soft bluish-green colour; their action is so speedy, that if the copper be exposed to the vapour of them for some minutes its surface will be immediately oxydated. The oxygenated muriatic acid produces that effect as well as the vapour of the nitric acid, and even those of the sulphuric acid. A phenomenon which cannot escape the eye of an

\* The best method of observing mountains, in order to acquire a thorough knowledge of them, is, not to confine oneself merely to follow the valleys, but to intersect also, as much as possible, the principal chains and the branches detached from them in the direction of their breadth. C.

† From *Annales de Chimie*, No. LXXV.

observer, is, that the oxydes of copper obtained by fire are very different from those produced by the decomposition of acids on that metal. The colour of them is grey, instead of being green; and when the calcination is continued a long time at a violent heat, they may be concentrated to a red oxyde of a blood colour. This phenomenon was observed by Kunckel in his chemical laboratory.

Saline substances are not the only ones capable of oxydating copper green. All oils and fat matters produce the same effect. Even water, when left for a considerable time in copper vessels, causes an oxydation. But what will appear very extraordinary is, that the greater part of these substances have no sensible effect upon copper, except when cold. Those salts even which corrode that metal when left at rest in vessels, do not attack it in so sensible a manner when in a state of ebullition.

Of all the preparations of copper by oxydation, there is none more valuable than that made by vinegar. All the verdigrise used in commerce is prepared by that acid, and it is at Montpellier in particular and in the neighbourhood, that the manufactories of it are established. In the Memoirs of the Academy of Paris for 1750 and 1753, may be seen a very exact description of the process then followed at Montpellier for making verdigrise; but as that process has been much improved, and as at present the husks of grapes are employed instead of the stalks, a method far more economical, since wine is no longer used, the following account of the manner of manufacturing verdigrise, as now practised, may be of utility to the public.

The first materials used for this purpose are copper and the husks or skins of grapes left after the last pressing. The copper employed was formerly all imported from Sweden; but at present it is brought from different foundries established at Saint Bel, Lyons, Avignon, Bedarieux, Montpellier, &c. It is in round plates half a line in thickness, and from twenty to twenty-five inches in diameter. Each plate at  
Montpellier

Montpellier is divided into twenty-five laminae, forming almost all oblong squares of from four to six inches in length, three in breadth, and weighing about four ounces. They are beat separately with the hammer on an anvil to smooth their surfaces, and to give the copper the necessary consistence. Without this precaution it would exfoliate, and it would be more difficult to scrape the surface in order to detach the oxydated crust. Besides this, scales of pure metal would be taken off, which would hasten the consumption of the copper.

The husks of grapes, known at Montpellier under the name of *racque*, were formerly thrown on the dung-hill after the poultry had picked out the small stones contained in them. At present they are preserved for making verdigrise, and sold at the rate of from fifteen to twenty livres per *muid*. The preparation of them is as follows: After the vintage is finished, the husks are subjected to the press, in order to extract all the wine with which they may be impregnated, and they are then put into vats, where they are pressed down with the feet to fill up all the vacuities and render the mass as compact as possible. The coverings of these vats are carefully fastened down, and they are preserved for use in a dry cool place.

These husks are not always of the same quality: when the grapes contain little of the saccharine matter, when the season has been rainy, the fermentation incomplete, or when the wine is not generous, the husks are attended with several faults. 1. They are difficult to be preserved, and there is great danger of their soon being spoilt. 2. They produce very little effect, cannot be easily heated, send forth very little of the acetous odour, and make the plates of copper sweat without shewing efflorescence on their surface. Independently of the nature of the grapes and the state of the wine, the quality of the husks varies also according as they have been expressed with more or less care. Husks which have not been much pressed, produce a far greater effect than those which have been dried. To explain their different effects,  
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it will be sufficient to observe that their action is proportioned to the quantity of wine they retain, as it is that liquor alone which can pass to the state of vinegar. When the husks therefore are destined for a verdigrise manufactory, care must be taken to express them only weakly, in order to preserve more of their acidifiable principle.

When a sufficient quantity of copper and of husks has been provided, nothing remains but to proceed to the operations, which are generally performed in cellars. They may be performed also on a ground floor if it be somewhat damp, if the temperature be subject to little variation, and if there be not too much light. The first operation is to make the husks ferment, which is called *avina*. For that purpose one of the vats is opened, and the husks are put into two others of equal size, taking care to expose them as little as possible to the air, and not to compress them. One vat full of husks ought to fill two, and to occupy a double space after this operation. In some manufactories the husks contained in a vat are distributed into twenty or twenty-five earthen vessels or jars called *oules*, and which are generally sixteen inches in height, fourteen in diameter at the belly, and about twelve at the mouth. When the husks have been put into these vessels, they are covered by putting the lid merely on the opening without pressing it down. The covers are of straw, and made for that purpose. In this state the husks soon heat; and this change may be known by thrusting the hand into them, and by the sour smell which they begin to exhale. The fermentation first takes place at the bottom of the vessel, and gradually ascending extends itself to the whole mass. It proceeds to 30 or 35 degrees of Reaumur.

At the end of three or four days the heat decreases, and at length ceases entirely; and as the manufacturers apprehend the loss of a portion of the vinegar by the natural effect of a heat too much prolonged, they take care after three days fermentation to remove the husks from the fermenting vessels, in order that they may sooner cool. Those who employ vats  
remove

remove them into jars, and those who use jars put them into others. Besides the loss of the acetous spirit, too great heat inclines the mass at the bottom of the vessel to become mouldy, which renders it unfit for making verdigrise. Some manufacturers, to increase the effect of the husks, form them into heaps, which they besprinkle with generous wine before they bring them to ferment.

The fermentation does not always take place at the same time, nor with the same energy. Sometimes it commences in twenty-four hours, and sometimes it has not begun at the end of three weeks. The heat sometimes will rise to such a height that the hand cannot be kept in the mass, and that the acetous odour is so strong that one can hardly approach the vessels; while at others the heat is hardly sensible, and soon vanishes. There are even instances of the husks becoming putrid and mouldy without turning acid. The fermentation is assisted and promoted by raising the heat of the place by means of chafing-dishes, by covering the vessels with cloths, by shutting the doors, and by airing the mass with more care. The differences in the fermentation depend,

1. On the temperature of the air: in summer the fermentation is speedier.
2. On the nature of the husks: those which arise from very saccharine grapes heat more easily.
3. On the volume of the mass: a larger mass ferments sooner, and with more strength, than a small one.
4. On the contact of the air: the best aired husks ferment best.

At the same time that the husks are made to ferment, a preliminary preparation called *desafouga* is given to the plates of copper which are used for the first time. This operation is not employed for those which have been already used, and consists in dissolving verdigrise in water in an earthen vessel, and rubbing over each plate with a piece of coarse linen dipped in this solution. The plates are then immediately placed close to each other, and left in that manner to dry. Sometimes the plates are only laid on the  
top

top of the fermented husks, or placed under those which have been already used for causing the copper to oxydate. It has been observed, that when the operation called *desafouga* has not been employed, the plates grow black at the first operation, instead of becoming green.

When the plates are thus prepared, and the husks have been brought to ferment, the workmen try whether the latter are proper for the process, by placing under them a plate of copper, and leaving it buried there for twenty-four hours. If the plate of copper, after this period, is found covered with a smooth green crust, in such a manner that none of the metal appears, they are then thought fit for being disposed in layers with the copper. On the other hand, if drops of water are observed on the surface of the plates, the plates are said to *sweat*, and it is concluded that the heat of the husks has not sufficiently subsided. They consequently defer making another trial till the next day. When they are assured that the husks are in a proper state, they form them into layers in the following manner :

The plates are all put into a box, which, instead of having a bottom, is divided in the middle by a wooden grate. The plates disposed on this grate are so strongly heated by a chafing-dish placed under them, that the woman employed in this labour is sometimes obliged to take them up with a cloth, in order that she may not burn her hands. As soon as they have acquired that heat, they are put into the jars in layers with the husks. Each jar is then closed with a covering of straw, and left to oxydate. This period is called *coûta*, to hatch. Thirty or forty pounds of copper, more or less according to the thickness of the plates, are put into each jar. At the end of ten, twelve, fifteen, or twenty days, the jar is opened ; and if the husks are white, it is time to take out the plates. The crystals are then seen detached, and of a silky appearance on their surface. The husks are thrown back, and the plates are put in what is called *relai*. For that purpose

pose they are immediately deposited in a corner of the cellar on sticks ranged on the floor. They are placed in an upright position, one leaning against the other; and at the end of two or three days they are moistened, by taking them up in handfulls and immersing them in water in earthen pans. They are deposited quite wet in their former position, and left there for seven or eight days; after which they are once or twice immersed again. This immersion and drying are renewed six or eight times, every seven or eight days. As the plates formerly were put into wine, these immersions were called *one wine, two wines, three wines*, according to the number of times. By this process the plates swell up, the green is nourished, and a coat of verdigrise is formed on all their surfaces, which may be easily detached by scraping them with a knife.

Each jar furnishes five or six pounds of verdigrise at each operation. It is then called fresh verdigrise, moist verdigrise, &c. This verdigrise is sold in that state by the manufacturers to people who dry it for foreign exportation. In this first state it is only a paste, which is carefully pounded in large wooden troughs, and then put into bags of white leather, a foot in height and ten inches in diameter. These bags are exposed to the air or the sun, and are left in that state till the verdigrise has acquired the proper degree of dryness. By this operation it decreases about fifty per cent., more or less according to its primitive state. It is said to stand proof by the knife, when the point of that instrument pushed against a cake of verdigrise through the skin cannot penetrate it.

The plates of copper which have been already used are again employed for the same operation, till they are almost completely consumed. Instead of heating them artificially, as above mentioned, they are sometimes exposed only to the sun. The same plates will serve sometimes for ten years, but they are often worn out in two or three. This, however,  
depends

depends on the quality of the copper. That which is extremely smooth, well beat, and very compact, is always most esteemed.

Formerly moist verdigrise could not be sold till its quality had been previously ascertained; and for that purpose it was carried to a public warehouse, where it was sold after that point had been determined.

By comparing this process with that described by Montet, it will be found that the changes introduced are much in favour of the new. Formerly the workmen took the stalks of the grapes dried in the sun, and began by immersing them for eight days in *vinasse* (the residuum of the distillation of wine for making brandy). They then suffered the moisture to drain off through a basket, after which they put about four pounds into a jar, and poured over them three or four pints of wine. The stalks were made to imbibe a large portion of the wine, by stirring them strongly with the hand; the jar was then covered, and the stalks were suffered to ferment. The fermentation commenced sooner or later, according to the nature of the wine and the temperature of the air. But after it had once begun, the wine became turbid, and exhaled a strong odour of vinegar. At length the heat decreased, and the stalks were then taken out and the wine was drawn off. When the stalks were a little drained, they were disposed in layers with the plates of copper, and the operation was continued in the same manner as with the husks. When the plates were taken from the jars to be put in *reloi*, instead of immersing them in pure water, as is done at present, they were moistened three or four times with four wine, which was called giving them three or four wines.

It may be easily seen that there is a great saving in the process followed at present, since the manufacturers no longer use wine, which enhanced the price of the verdigrise. Some have condemned, in the new process, the practice of using the copper too soon; but this objection fell to the ground, when



when it was observed that the verdigrise obtained was in proportion to the copper corroded; and what proves that this method is more advantageous, is, that all the manufacturers have abandoned the old method and adopted the new\*.

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XII. *On the Method of preparing Tallow Candles with Wooden Wicks.* By Professor MEDICUS of Heidelberg†.

“FOR several years past tallow candles with wooden wicks have been prepared, in large quantities, by the candle-makers at Munich, and much used in that neighbourhood. I have burnt them during the whole winter, and never wish to use any other kind, as they are attended with several advantages which common tallow candles do not possess. They afford about the same quantity of light as a wax candle; burn also with great steadiness and uniformity, and never crackle or run. The candle-makers here keep the method of preparing these candles as secret as they can; but I shall communicate to the public what I have been able to learn respecting the process.

“The only difference between these candles and the common tallow candles is, that the ground work of the wick consists of a very thin slip of wood, bound round to a considerable thickness with very fine unspun cotton; but in such a manner that the size of the wick does not much exceed that of the wick of a common candle. The cotton is wound round the wick by the hand; but in general it is done by means of a reel, which I have not yet been able to see. The thin slips of wood are furnished to the candle-makers by the country people, and, if we may judge from

\* There are no large manufactories of verdigrise at Montpellier; but each family makes a certain quantity, and the operations are in general performed by women.

† From *Riemer's Neue Sammlung Oekonomischer Schriften*, part xii.

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their appearance, are cut into the proper form by means of a knife, without the application of any machine. They are for the most part somewhat square, and not completely rounded. The candle-makers often prepare these slips of wood also themselves, when they have none ready by them, and for that purpose use pine, willow, and other kinds of wood, though they commonly employ fir. For making these candles it is necessary to have the purest tallow: a pound will be sufficient to make six or seven, which cost 25 kreutzers. The price of common moulded candles with cotton wicks is 22 kreutzers; but as the former burn much longer, they are on the whole cheaper."

Another method of making the wicks is as follows: Take shoots of the pine-tree a year old, scrape off the bark, and when they are become perfectly dry scrape them again all round till they are reduced to the size of a small straw. When the above wood cannot be procured, well dried common fir twigs of a year old, and of the same strength, may be prepared in the like manner. These rods are then to be rubbed over with wax or tallow, till they are covered with a thin coating of either of these substances; after which they must be rolled on a smooth table in very fine carded cotton, drawn out to about the length of the rod or candle-mould. Care however must be taken that by this rolling no inequalities may arise on the rod, and that the cotton may be every where of equal thickness, though at the upper part a little more of it may be applied. After this preparation the wick will have acquired the size of the barrel of a small quill; and the more accurately the size of the wick is proportioned to that of the candle mould, the candles will burn so much the better, clearer and longer, as will soon be found by a little experience: these wicks are then to be placed very exactly in the middle of the mould, and retained in that position, and good tallow, fresh if possible, previously melted with a little water, must be poured round them; but even old and rancid tallow will not run, if the wicks be properly made.

These candles, besides burning longer than the common ones, have also this advantage, that they do not flare, and that they are less prejudicial to the eyes of those who are accustomed to read or write at night. It is however to be observed, that a pair of sharp scissars must be employed for snuffing them, and that in performing that operation care must be taken not to break or derange the wick.

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XIII. *Experiments on the Colouring Matter of Vegetable Juices with the Tungstic Acid.* By Cit. GUYTON.

IN the second volume of the Philosophical Magazine, page 126, we laid before our readers a paper by the same author on the colouring matter of vegetables, and the action exercised on it by metallic substances and their oxyds; with a new process for obtaining lakes of more intense and fixed colours. The present may be considered as connected with that paper, being, in fact, a detail of the experiments with tungsten, on which the conclusions there given were established.

“ Having subjected to experiment an oxyd hitherto little known, I mean the tungstic oxyd, I soon discovered that it is one of the most valuable substances for receiving and fixing vegetable colours. I digested the juice of the red plum with the white oxyd of tungsten, procured from wolfram, that is to say, in the state in which it is considered as an acid. The liquor lost a great deal of its colour, and the metallic oxyd became of a very dark red violet. I decanted the liquor, and boiled it on a new portion of the tungsten. It assumed the same colour, and the liquor still retained a faint shade of red. The liquor being filtered and diluted with water, to defend it from the action of the fire, was treated a third time with fresh oxyd. It then remained colourless, and the oxyd of tungsten was found coloured as much as the first.

\* From *Annales de Chimie*, No. LXXXIX.

‘ It was not now necessary to examine the liquor by reagents, for principles which no longer existed in it, but to try whether the colour adhering to the oxyd was fixed there in such a manner as to promise any advantages to dyeing, or at least to painting. Water boiled a long time, and in succession, on this oxyd rather darkened than weakened its colour. This water made no impression upon turnsol paper. Though limpid, it assumed, by the addition of the muriatic acid, a shade of a pale rose red colour; and by the addition of pot-ash, a greenish shade; but these colours totally disappeared in a few minutes, and could not be made to reappear, by pouring over them fresh acid and fresh alkali. What is more remarkable, the hydro-sulphure brought back a slight tint of violet, which did not disappear.

“ A portion of the coloured oxyd of tungsten was mixed up with gum water, and with a brush daubed over a piece of paper. The stratum being dry, a thin scale of it was detached, in order to be exposed to the rays of the sun, and at the end of nine days the colour was neither changed nor weakened. Another scale was immersed in the acetous acid; and being immediately drawn out and dried, it was found to have experienced no change. As little effect was produced upon it by the acetic acid. Lime water applied to it left no sensible traces of its effect. The case was the same with ammonia. A solution of soap only weakened the tint without changing it. A solution of potash made a red spot, in which the violet shade was destroyed. A solution of the carbonat of potash produced an alteration still more sensible, the part which had been touched inclining rather to yellow than to red. A solution of alum, even concentrated, effected no change. A sheet of paper, tinged with the colour of this oxyd, being kept for twenty-four hours in a close jar, at the bottom of which was some hydro-sulphure, no change whatever was observed. In the last place, a sheet of this paper exposed to the vapour of the oxygenated muriatic acid, at the same time as a like sheet of paper coloured by turnsol,

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the latter lost all its colour, while that of the former was not sensibly weakened.

“ The kind of lake formed by the union of vegetable colouring matter with the oxyd of tungsten may be considered, therefore, as having been subjected to the strongest test by the principles most destructive to colours, and which Berthollet considers as the nearest, in point of strength, to the continued action of the air and light.

“ I shall pass over a great number of other experiments less direct, or at least less conclusive, respecting other vegetable colouring matters, and observe only that the oxyd of lead, which seems to have so little action on the red juice of stoned fruits, attacks turnsol very strongly; that an infusion of turnsol, rendered red by the acetous acid, passes to a wine colour when treated with iron, and is then in the state of violet juices which become green by alkalies; that the acid juice of yellow fruits, melons for example, gives to the oxyd of tungsten only a faint shade of blue, which turns grey by repeated washing; and that, on the other hand, this oxyd, digested in infusions of curcuma (turmeric) and turnsol, becomes charged with their colours, and gives them a fixity of which one would not have supposed them susceptible.”

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XIV. *Description of an Apparatus in the Teylerian Museum for the Combustion of Phosphorus in Oxygen Gas; with Observations on the Shining of Phosphorus in Azot.* By D. VAN MARUM of Haarlem\*.

HAVING made several fruitless attempts to render a balloon for the combustion of phosphorus perfectly air-tight, according to the method described by Lavoisier in his Elements of Chemistry, I constructed another like that which I employ-

\* From *Description de quelques appareils Chimiques*, &c. by Dr. van Marum.

ed for the composition of water, and secured against the entrance of air in the like manner. This balloon, represented by A (Plate II.), has two cocks B C with conical stoppers, and united to the tubes by the same means as those in the gazometer above mentioned\*. Within the balloon is a small crucible of platina, *d*, suspended by two wires of the same metal from the plate of copper by which the balloon is shut. The cock B serves to connect the tube with an air pump, and by these means to empty the balloon of atmospheric air. By the cock C, the oxygen gas, contained in the gazometer G, is introduced; but as this gas ought to be as dry as possible before it is admitted into the balloon, I have applied between it and the gazometer a glass cylinder, H, filled with a salt which strongly attracts the moisture of the gas. The salt which I found most effectual in this experiment was that used and recommended by Saussure for drying atmospheric air†. It is the alkali which remains after the decrepitation of a mixture of equal parts of nitre and crude tartar, and which has been kept at a red heat for an hour.

The salt in the tube H must not be pulverised, but divided into small fragments, in order that the gas may penetrate through it, and come in contact with a greater portion of its surface. The tubes *i*, *u*, *k*, by which the cylinder H is connected with the gazometer and the balloon, must be pliable, because it would be too difficult to place the cylinder H in such a position as to be united with the balloon and gazometer by means of tubes not capable of being bent. I employ pliable tubes of gum elastic, the ends of which are fastened to the copper pipes screwed into the cocks.

Lavoisier kindled the phosphorus in the balloon by a burn-

\* For a description of the gazometer, or apparatus for producing water by combining hydrogen with oxygen, here referred to, see the *Philosophical Magazine*, vol. ii. p. 85.

† See De Saussure's *Essais sur l'Hygrometrie*, p. 25.

ing glass. I have observed that phosphorus wrapt up in a particular manner inflames spontaneously when the air is rarefied to a certain degree; and I employ the result of this observation to inflame the phosphorus in the balloon.

By means of this apparatus I have several times, both in the course of my lectures and on other occasions, shewn the production of the phosphoric acid by the combustion of phosphorus in oxygen gas, as described by Lavoisier in the *Memoirs of the Academy of Sciences* for the year 1777, (page 65.) In my experiments I have generally burnt sixty grains of phosphorus. They have shewn that the weight of the phosphoric acid produced is always nearly equal to that of the phosphorus burnt, and of the oxygen gas employed. I calculated the results by the method described by Lavoisier in his *Treatise of Chemistry* (vol. ii.); but it is not necessary they should be inserted here, as the composition of the phosphoric acid has been sufficiently established by the accurate experiments of Lavoisier. My object, in describing the apparatus I employed, was merely to enable those who wish to repeat the experiments to do so by an easier method, and with more certainty than according to that proposed by him. It must here be observed, that as the phosphorus, by my process, inflames in rarefied air, there is no danger that the sudden expansion of the air, produced by the intense heat of the inflamed phosphorus, will burst the glass; to prevent which, in Lavoisier's method, requires great caution, as he himself has remarked. That the balloon during the combustion may be as little heated as possible, I suffer the air, after the inflammation, to pass gradually, and in small quantity, into the glass globe, and for that reason do not open the cock until the flame begins to be extinguished. In this manner the experiment may be performed without any danger.

In the year 1794 I made known, in the thirteenth number of the *Chemischen Oeffnungen* of the celebrated Kassel-

lyn, my experiments on the combustion of phosphorus in the so called vacuum of an air pump. Had professor Götting, and other German chemists who have observed phosphorus to shine in azotic gas, paid more attention to what these experiments clearly establish, they would not have made so much noise respecting a phenomenon which is so like the shining of phosphorus before it inflames in air highly rarefied. This shining of phosphorus in an imperfect vacuum, shews that the small quantity of oxygen gas contained in atmospheric air so highly rarefied, is still sufficient to occasion that luminous appearance; and as it is well known that it is absolutely impossible to produce azotic gas which does not contain some oxygen gas, they might have seen by my experiments, that the small quantity of oxygen which must have been contained in their azotic gas was sufficient to produce that light which they observed.

I shall here only add, that phosphorus will not shine at all in azotic gas which contains no oxygen gas. This I shewed, on the 18th of January 1794, in my lectures at the Teylerian Institute. I introduced azotic gas over mercury, and freed it totally from oxygen gas by introducing phosphorus into it on the point of a bent iron wire, which I passed up through the mercury, so as to bring the phosphorus in contact with a piece of ignited iron previously introduced into the receiver. All the oxygen gas united itself in a moment with the volatilized phosphorus; and another bit of phosphorus, which after the cooling of the apparatus I made to rise through the quicksilver into the azotic gas, which in that manner was freed from all oxygen, did not shine. A small bubble of atmospheric air was sufficient to reproduce the shining. It was then seen diffused throughout the whole gas, in the same manner as when atmospheric air is admitted into an exhausted receiver in which phosphorus has ceased to be luminous. I shewed, in the course of the same lecture, that phosphorus does not shine in a perfect vacuum.



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vacuum. For this purpose I caused the phosphorus to ascend through the quicksilver of a barometer, and it exhibited no light\*. In order that this experiment may completely succeed, you must employ a barometer, the tube of which has been well freed from atmospheric air, by boiling the quicksilver in the tube. If you use a barometer the quicksilver of which has not been boiled, the small quantity of air contained in it will be sufficient to make the phosphorus luminous; but this appearance will be of short duration, because the exhausted space of such a barometer can contain only a very small quantity of oxygen gas.

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XV. *A simple Method of determining the magnifying Power of Telescopes.* By Mr. S. VARLEY. Communicated by the Author †.

THOUGH the subject on which I wish to trouble you with a few observations must be well understood by many of

\* It has been already incontestably proved by experiments, that phosphorus is not luminous in a vacuum. Besides those mentioned in the treatise entitled *Ueber das Leuchten des Phosphors im atmosphärischen Stickgas*, Weimar 1795, p. 58, may be mentioned the following: Hawksbee approached very near to this discovery, and to that also, made by the author, of phosphorus inflaming in vacuo. He drew some lines with phosphorus on a piece of paper, and suspended it within the receiver of an air pump. "After long pumping," says he, "the luminous appearance was apparently brighter." See the *Philosophical Transactions*, vol. xxiv. p. 1865. Lemery mentions experiments of the like kind made by Homberg, in conjunction with M. D'Alence, at Paris, and which correspond exactly with those of Hawksbee. See his *Cours de Chymie*, Paris 1687, p. 577. Lavoisier found that phosphorus did not inflame, *Memoires de l'Academie*, an. 1777, p. 65; and Professors Lempe and Lampadius, that phosphorus was not luminous in the Torricellian vacuum. See Scherer's *Nachträge*, p. 200.

† A "Constant Reader," in a letter of 23d May, but which did not reach us in time for our last Number, proposed the following question:

your readers, I have had many opportunities of being convinced that it is not so generally known as it ought. Since I first ventured to give public lectures on optics, and to explain the various constructions of telescopes and microscopes, I have frequently been applied to, to procure those instruments for people residing at a distance from the metropolis, and to prove them before sending them off. I have also been frequently requested by those who had purchased such instruments to give an opinion of their goodness, and to determine their magnifying powers; from which I have found that the manufacturers of those instruments too generally are in the habit of over-rating their powers\*, to the great disappointment of the buyer, who finds, when too late, that they will not perform what he had been taught to expect from them.

From what I have stated, it appeared to me, that a method to determine the magnifying power of telescopes, without much trouble or expense, and yet sufficiently exact for most purposes, might be thought worth a place in your useful publication. There are various methods of doing the same thing, and each have their particular advantages and disadvantages: some are expensive; others require long calculations: some are attended with much trouble; and others require particular situations, which cannot always be commanded. The method I mostly use can be universally ap-

“What is the method used by opticians to ascertain the magnifying power of telescopes? and how do they *prove* how many times the object is magnified, when seen through the same?”

The present paper, he will see, furnishes a satisfactory answer. EDIT.

\* Even that eminent artist Mr. James Short, who rendered himself so justly famous by bringing the reflecting telescope to a degree of perfection unknown before his time, too often over-rated the power of his telescopes, though not in the same shameful degree that some makers now do. I would not however be understood as making this censure general: I know one artist whose reflecting telescopes exceed even those of Short, and whose telescopes I have never once found of less magnifying power than they were sold for; and I hope there are others who are above being guilty of so mean an artifice.

plied,

plied, and at almost no expence; a small scale, a pair of compasses, and a piece of paper, being all that is necessary.—It may be proper, in the first place, to state the sense in which I use the term *magnifying power of a telescope*; for it is differently understood by different persons: also to distinguish between the object itself, and the magnified image of the object looked at, as seen in the field of the telescope. The difference in size, between the object viewed with the naked eye and its image as seen in the field of the telescope, constituting the magnifying power of the telescope, the question is, How ought this difference to be expressed? Should it be expressed in a comparison of their respective diameters, areas, or solidity? For instance, if a piece of paper of three inches square, crossed each way by three lines, and thus divided into nine squares, be placed at a distance, and viewed by a telescope that causes one of those squares to appear as large as the whole paper, at the same distance, appears to the naked eye; if we compare this effect by the difference in diameter, we should say, *the instrument magnifies three times*: but as one square appears as large, when seen through the telescope, as the whole nine do to the eye unassisted by that instrument, might it not be asserted, with equal truth, that it is magnified nine times? The latter appears as reasonable as the former; but, as in this case the paper appears, when viewed by the telescope, of the same dimensions as it would do to the naked eye when placed *at one third the distance from the observer*, it is most usual to say, it is magnified three times. Some people, who yet mean the same thing, say, but improperly, that it appears three times nearer than it really is. Again, if an object at the distance of 100 yards appears by the telescope as large and distinct as it would do to the naked eye at the distance of one yard, it is said to be magnified one hundred times; and it is to be understood in this sense in the following experiments:—By a telescope of the last mentioned power, a printed paper, at the

distance of 100 yards, can be as distinctly read as it could by the eye at the distance of one yard; and it is owing to this astonishing property that the heavenly bodies can be contemplated as though they were only the one, two, three, four, or five hundredth part the distance that they are in reality.

The planets, for instance, have nothing in their appearance to the naked eye, that would engage our particular attention, or enable us to distinguish them from the fixed stars, except their being observed to change their places amongst the fixed stars, sometimes moving from west to east, then for a season remaining stationary, having no *apparent* motion at all; then again, to have a little motion from east to west, which keeps increasing a certain time, when it again decreases, until they once more become stationary. They were thus distinguished from the fixed stars long before telescopes were invented, and on this account were called erratics, or wandering stars, their real and regular motions and periods being at that time unknown. But, by the assistance of the telescope, in each of them may be observed what excites astonishment and claims our particular attention, especially if the instruments are good of their kind, and magnify from two to four hundred times. In viewing Saturn, the slowest, and now known to be the most distant planet of all, except the Georgium Sidus, instead of a pale solitary wanderer, he is found to be accompanied with six or seven moons, revolving round him at stated, fixed, and regular periods, and to be encompassed with (a greater wonder still) a double ring, no where touching him, but suspended so as to have its inside edge every where twenty-one thousand miles from his body. The planet Jupiter is observed to have several belts that appear, though upon his body, as having several spots, by which his diurnal motion on his axis is determined to be much quicker than that of our earth, being performed in about eight hours, notwithstanding he is so much larger,

He is also seen to be accompanied with four moons, or satellites, revolving in certain periods: even their eclipses, which afford an excellent method for determining the longitude of places on our earth, can be distinctly seen. Mars is observed to have some spots near one of his poles, by which he is known to have a diurnal rotation round his axis. The beautiful planet Venus, that now adorns our evening sky, is observed to wax and wane like our moon; sometimes being merely a crescent, then horned like the moon only a few days old, then gibbous, afterwards full; exhibiting different phases like our moon, and thus affording an incontestible proof of the Newtonian system of astronomy, now universally adopted by men of science in every part of the world\*.

The planet Mercury, though but seldom seen, yet deserves our attention, as he more frequently than Venus passes betwixt the sun and us, appearing like a patch upon the disc of the sun, and thus, to those that know how to avail themselves of these phenomena, gives additional proof of the truth of the present system. The splendid face of our moon, in her various phases, offers so many similarities to the earth which we inhabit, as leave but little room to doubt she is destined for the same grand end, an habitation for in-

\* The truth of this system has been proved by innumerable observations made with this excellent instrument, by men every way qualified to judge, who with unwearied diligence, and without any bias or motive whatever but a strong desire to search out the truth, have examined and proved every part of it, and fixed it upon too strong a basis to be overturned or refuted by the ignorant or interested, who pretend to do so without possessing one single qualification to enable them to form a proper judgment in this matter, or a single pretension but what is founded in the grossest ignorance, accompanied with the most consummate assurance. But enough of this at present. Perhaps at a future opportunity I may offer some remarks upon, and throw together some of the leading features of the Newtonian system, for the sake of those who, for want of better information, are daily duped out of their money by the contemptible jargon of even the most ignorant and stupid of mankind.

telligent beings; thus answering the double purpose of an additional light to us, and a convenient habitation for others; while she, in return, receives a like benefit from the earth, which answers the purpose of a luminary to her. She is seen to have broad seas, bounded with rocky shores; extended continents, diversified with hill and dale; deep valleys and towering mountains; mountains, whose extended shadows can be traced, and as distinctly seen, as the shadow of a sun-dial; and, lately discovered (owing to the great improvements made in telescopes), volcanic or burning mountains.

An easy method to determine the magnifying power of those instruments, whose excellence it is to have made us intimately acquainted with the various phenomena above mentioned, and which give us sources of enjoyment from the contemplation of distant terrestrial objects, of which our forefathers had no conception, cannot but be acceptable to many, especially to those who have not the opportunity of employing the more expensive processes that are resorted to for the same end.

The simplest method is, to measure the emergent pencil or cone of light, as it appears, in the eye-hole of the telescope, and to divide the diameter of the aperture of the object-glass, if it is an achromatic, or of the great milla, if a reflector, by the diameter of this emergent pencil, and it will give the magnifying power. For this purpose, I take a piece of thin writing paper, a little more than two inches in length, and about half an inch in breadth; I draw with a good pen, or other proper instrument, the line *a, b*, fig. 28, (Plate I.) and then, with a pair of good dividers, I take from a scale one tenth of an inch, which I set off from *b* to *c*, and then, with the same extent, divide the line *a, b*, into 20 equal parts, making visible marks or punctures at each division. I then draw the line *a, c*, and make the divisions 1, 2, 3, 4, &c. to 10, at every other division or point made with the dividers, and put a little sweet oil upon the paper

to make it more transparent. I sometimes omit making the lines 1, 2, 3, &c. and content myself with numbering every second hole made by the dividers; the numbers are to express, in hundredths of an inch, the distance of the lines *a*, *b*, and *a*, *c*, at those points where they are placed. Being thus provided, I adjust the telescope to distinct vision, by looking at some distant object, and then take off the eye-hole, if the telescope will admit it to come off, which reflectors always do, but the night eye-pieces of achromatics do not without taking away the first glass also. Having now directed the telescope to the open day-light, I take the divided paper in one hand, and a hand magnifier to view it with in the other, and apply the paper to measure the diameter of the bright pencil of light as it emerges from the eye-glass, and at that distance where it appears least in diameter, as at *c*, fig. 29, where the rays of light, having passed the lens *a*, converging to *c*, there cross each other, and proceed diverging to *d* and *e*: this place, where the paper is to be applied, will be easily known by observing, with your hand magnifier, (which should be of an inch, or at most an inch and half focus,) where the bright spot, as at *d*, fig. 28, appears distinct and well defined at the edges, and the filaments of the paper distinctly seen at the same time. A place on the paper may be found, where the bright spot will just fill up the space between the lines *a*, *b*, and *a*, *c*. Suppose this takes place at *d*, where it will be extremely near the third division, and of course three hundredths of an inch in diameter; and suppose your telescope to be a 30-inch achromatic, and the diameter of the object glass two inches and one tenth, or 210 such divisions; these, divided by three, will give 70 for the magnifying power of your instrument. Suppose, with a different eye-piece, the pencil of light only occupied the space between the lines at *i*, it would be one and one half of those divisions: in this case divide 210, the hundredths of an inch contained in the diameter of your object glass, by 1.5, and  
it

it will give 140 for the magnifying power. Again, suppose, with some other eye-piece the beam of light fills the lines at the fourth division: divide your 210 by 4, and it will give 52.5 or 52, for the power. If your paper be oiled with good linseed oil that has been boiled, such as the painters call drying oil, it will last for many years, and have this advantage over the instruments made for this purpose which are sold for 3l. 3s. that, as the screw for receiving the dark glass projects beyond the place where the paper should be held, the paper will bend, and thus can be introduced into its proper situation without producing any sensible error. Another method, which I sometimes use in confirmation of the former, and which cannot fail to produce full conviction on the mind, is as follows: I measure the space occupied by a number of the courses of brick in some modern brick building, which, upon an average, will be found to have eight courses in two feet: hence each course is three inches. I then cut a piece of paper three inches in height, and nearly of the length of a brick, which is about nine inches, so that it may represent a brick, but with this advantage, that its edges will be much better defined; and fixing the paper against the wall (see fig. 27), place the telescope to be examined at the distance of 50 or 100 yards from the wall; and looking through the telescope at the paper with one eye, and at the same time with the other eye looking past the telescope, I observe what extent of wall the magnified image of the paper appears to cover. I then count the courses of bricks in that extent, which gives the magnifying power of the telescope. This method will appear a little difficult at first, but, by a few trials, will become so familiar, that the paper, as seen by the telescope, may be easily compared with the bricks seen by the other eye.

I intended to have added several other observations on subjects nearly related to the above; but having exceeded the



the bounds I proposed to myself, must reserve them for a future number, if you should think subjects of this nature worth insertion\*.

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XVI. *Sixth Communication from Dr. THORNTON, Physician to the General Dispensary, &c. &c. relative to Pneumatic Medicine.*

A REMARKABLE CASE OF PULMONARY DISEASE  
CURED BY THE INHALATION OF HYDRO-AZOTE.

MR. GREGORY, M. P. of Berner's-street, who had been long resident in India, laboured for several months under all the symptoms of phthisis pulmonalis. He expectorated a quantity of thick, opaque, and yellowish matter which sunk in water, had disturbed nights, was greatly wasted, and his breathing was short and interrupted. He took by my order (which was executed by Mr. Leaton, a very ingenious apothecary and able chemist, who lives in Bridge-street, Westminster) from four to six quarts hydro-azote daily, mixed with twelve of atmospheric air, and at the same time had a mixture of myrrh and bark, with opiates occasionally; and under this treatment the cough was soon diminished, and in six weeks the patient was restored to health, and has continued free from every complaint these eight months; even a cold now passes off without exciting any symptoms of alarm. Dr. Hooper, of the Mary-le-bone Infirmary, and several others of the Faculty, who have seen this case, think that it may be produced as a very strong argument in favour of the pneumatic practice.

\* Subjects handled in the familiar and popular manner which Mr. Varley so successfully follows, cannot fail to be useful, not only to the casual examiner, but to men of science; and we shall be happy to receive his communications as often as his other avocations will allow. EDIT.

*Observation.*

*Observation.*

The hydro-azote is made by burning æther under a bell-glass, when the oxygen unites with the hydrogen and forms water, and the residue is azotic air; a species of heavy, inflammable, or hydrogen air, and some æther in the state of vapour, and a small proportion of fixed air. I have myself inhaled ten quarts of this pure, and the pulse has sunk from eighty to seventy beats in a minute, and continued so for a quarter of an hour or more. It is very grateful to the lungs; and I flatter myself, that this new species of air, first employed by me, may prove hereafter a valuable acquisition to the *ars medendi*. As we brace the constitution with tonic medicines, there is danger of local inflammation, which this appears to obviate; or, has the hydro-azote any peculiar healing quality?

XVII. *Biographical Memoirs of M. de SAUSSURE.*

By A. P. DECANDOLLE †.

**H**ORACE BENEDICT DE SAUSSURE was born at Geneva in 1740. His father, an intelligent farmer, to whom we are indebted for some memoirs relating to rural economy, resided at Conches, a place situated on the banks of the Arve, at the distance of half a league from Geneva; and this country life, added to an active education, expanded no doubt in young De Saussure that physical strength so necessary to the naturalist who devotes himself to travel. He repaired daily to town to enjoy the advantage of public instruction; and as he lived at the bottom of Saleve, a mountain which he has since rendered celebrated, he amused himself frequently with ascending its steep and rugged sides. Being thus surrounded by the phenomena of nature, and at the same time aided by study, he conceived a taste for natural history, and avoided the error both of the learned, who form theories without

† From *Decade Philosophique*, No. XV.

having been out of their closets, and of those farmers who, living too near to nature, are incapable of admiring her beauties.

His earliest passion was botany: a variegated soil, abundant in plants of different kinds, invites the inhabitant of the banks of the Lemán to cultivate that agreeable science. This taste produced an intimacy between De Saussure and the great Haller. He paid him a visit in the year 1764, during his retreat to Bex; and he relates in his travels how much he admired that astonishing man, who excelled in every part of the natural sciences. De Saussure was induced also to study the vegetable kingdom, by his connexion with Ch. Bonnet, who had married his aunt, and who soon set a just value on the rising talents of his nephew. Bonnet was then employed on the leaves of plants. De Saussure studied these organs of vegetables also, and he published the result of his researches, under the title of *Observations on the bark of leaves*. This small work, which appeared soon after the year 1760, contains new observations on the epidermis of leaves, and in particular on the milary glands by which they are covered\*.

About that period the place of professor of philosophy falling vacant, it was conferred upon De Saussure, who was then only twenty-one years of age. Experience proves, that if premature rewards extinguish the zeal of those who labour merely for themselves, they, on the contrary, strengthen it in those who labour only for truth. At that time the two professors of philosophy at Geneva taught physics and logic alternately. De Saussure discharged this double task with equal success. He gave to his course of logic a practical, and, as one may say, experimental turn; and his method of teaching, which began by studying the senses to arrive at the general laws of the understanding, announced already an able observer of nature.

Physics however were the part for which he had the greatest taste, and which conducted him to the study of chemistry

\* He had resumed this subject eighteen months before his death.

and mineralogy. He then began his travels through the mountains ; not now to examine their vegetable productions, but to study the mountains themselves, either in the stones of which they are composed, or the disposition of their masses. Geology, a science which was then scarcely in existence, added charms to his numerous excursions through the Alps ; and it was then that the talents of the great philosopher were really displayed. During the first fifteen or twenty years of his professorship, he employed himself by turns in discharging the duties of his office, and in traversing the different mountains in the neighbourhood of Geneva. He even extended his excursions on one side as far as the banks of the Rhine, and on the other to Piedmont. At the same time he undertook a journey to Auvergne to examine there the extinguished volcanoes, and another to Paris, England, and Holland. After that he visited Italy, and even Sicily. These were not mere journeys for the purpose of reaching any particular place. He undertook them only with a view of studying nature ; never travelled but surrounded by every instrument that could be of use to him, and never set out until he had drawn up a plan of the experiments and observations he intended to make. He often says in his works, that he had found this method exceedingly useful.

In the year 1779 he published the first volume of his *Travels through the Alps*, which contains a minute description of the environs of Geneva, and an excursion as far as Chamouni, a village at the bottom of Mont-Blanc. Philosophers will read there with pleasure the description of his *magnetometer*. The more he examined mountains, the more was he sensible of the importance of mineralogy. To study it with advantage, he learned the German language ; and it may be seen, in the last volumes of his Travels, how much new mineralogical knowledge he had acquired.

Amidst his numerous excursions through the Alps, and at the time of the political troubles of Geneva in 1782, he found means to make his beautiful experiments on hygrometry, which

which he published in 1783 under the title of *Essays on Hygrometry*. This work, the best that ever came from his pen, established fully his reputation as a philosopher. We are indebted to him also for the invention of a new hygrometer. Deluc had already invented his whalebone hygrometer; and on that account there arose between him and De Saussure a sort of contest, which degenerated into a pretty violent dispute.

In the year 1786 De Saussure resigned the professor's chair, which he had filled for about twenty-five years, to his pupil and fellow-labourer Pictet, who discharged with reputation the duties of an office rendered more difficult by succeeding so eminent a philosopher.

When De Saussure was invited by the state to take a share in the public education, he made it one of the subjects of his meditations, and presented the plan of a reform in the education of Geneva, the tendency of which was, to make young people early acquainted with the natural sciences and mathematics. He even wished that their physical education should not be neglected, and with that view proposed gymnastic exercises. This plan, which excited much attention in a city where every one is convinced of the importance of education, found admirers and partisans; but the poverty of its pecuniary resources was an obstacle to every important innovation. It was besides feared that, by altering established forms, they might lose the substance, and that things might be changed for the worse. The Genevese were attached to their old system of education; and they had reason to be so, because it had not only proved the means of diffusing knowledge generally amongst them, but had called forth the talents of several eminent mathematicians\* and philosophers†.

But De Saussure's attention was not confined to public edu-

\* Abauzit, Cramer, Lhuillier, J. Trembley, &c.

† Jalabert, A. Trembley, Bonnet, Lefage, Deluc, Senebier, Prévost, Pictet, and De Saussure himself.

cation alone. He superintended himself the education of his two sons and a daughter, who have shewn themselves worthy of such an instructor. His daughter to the charms of her sex unites an extensive knowledge of the natural sciences; and his eldest son has already made himself known by his physical and chemical labours.

The second volume of his Travels was published in 1786. It contains a description of the Alps around Mont-Blanc, which the author considers as a mineralogist, a geologist, and a philosopher. He gives also some interesting experiments on electricity, and a description of his electrometer, the most perfect we have. We are indebted to him also for several instruments of measurement, such as his *cyanometer*, destined to measure the degree of the blueness of the heavens, which varies according to the elevation of the observer: his *diaphanometer*, or instrument for measuring the transparency of the atmosphere; and his *anemometer*, which, by means of a kind of balance, weighs the force of the wind.

Some years after the publication of the second volume of his Travels, De Saussure was admitted as a foreign associate of the Academy of Sciences of Paris; and Geneva could then boast of having two of its citizens in that class, which consisted only of seven members. De Saussure not only did honour to his country: he loved and served it. He was the founder of the Society of Arts, to which Geneva is indebted for the high state of prosperity it has attained within the last thirty years. He presided over that society till the last moment of his life, and one of his fondest wishes was the preservation of this useful establishment.

In consequence of M. de Saussure's fatiguing labours in the Council of Two Hundred, of which he was a member, and afterwards in the National Assembly, his health began to be deranged, and in 1794 he was almost deprived of the total use of his limbs by a stroke of the palsy. However painful his condition then might be, his mind still preserved its activity;

activity; and after that accident he revised the two last volumes of his Travels, which appeared in 1796. They contain an account of his excursions to the mountains of Piedmont and Swisserland, and in particular of his journey to the summit of Mont-Blanc. These volumes, instead of exhibiting any marks of his malady, present an enormous mass of new facts and observations of the utmost importance to physics.

He rendered also an important service to that science by publishing the *Agenda*\*, which terminate his fourth volume, and in which that great man, surviving himself, conducts the young naturalist through the middle of mountains, and teaches him the method of observing them with advantage. These *Agenda* are a proof of his genius, and of the strength of mind which he retained amidst his sufferings. It was also during his illness that he published *Observations on the fusibility of stones by the blow-pipe*, and that he directed the experiments made on the height of the bed of the Arve\*. Having gone for the sake of his health to the baths of Plombiers, he still observed the mountains at a distance, and caused to be brought to him specimens of the strata which he perceived in the steepest rocks. He had announced that he would conclude his Travels with some ideas on the primitive state of the earth; but the more he acquired new facts, and the more he meditated on the subject, the more uncertain did his opinions become in regard to those grand revolutions which preceded the present epoch. In general he was a Neptunian; that is to say, ascribed all the revolutions of our globe to water. He admitted the possibility of the mountains having been thrown up by elastic fluids disengaged from the cavities of the earth.

Though the state of his health began gradually to become

\* Part of these *Agenda* have been already given in the *Philosophical Magazine*: the rest will be given in the subsequent numbers. EDIT.

\* His memoirs on these subjects were inserted in the *Journal de Physique*.

worse, he still entertained hopes of recovery ; and the French government having appointed him professor of philosophy at the Special School of Paris, he did not despair of being one day able to fill that office : but his strength was exhausted, a general languor succeeded the vigour he had always enjoyed, his slow and embarrassed pronunciation no longer corresponded with the vivacity of his mind, and formed a melancholy contrast with the pleasantness by which he had been formerly distinguished. It was a painful spectacle to see this great man reduced thus to imbecility at an age when meditation is beneficial, and when he ought at least to have enjoyed the fruits of his reputation and labours.

In vain did he try, for the re-establishment of his health, all the remedies which medicine enlightened by the physical sciences could afford—all assistance was useless. The vital power quitted him with slow and painful steps. Towards the beginning of autumn last year his decay became more visible, his mind lost all its activity, and on the 22d of March 1799 he terminated his brilliant career, at the age of 59, lamented by a family to whom he was dear—by a country to which he had done honour—and by Europe, the knowledge of which he had extended.

XVIII. *Letter from Dr. CARMICHAEL SMYTH to the Editor of the Philosophical Magazine.*

SIR,

**O**BSERVING in your Magazine of last month an article in which Mr. Cruickshank has corrected a mistake I had fallen into in relating an experiment of his on variolous matter; I have only to say, that had this gentleman informed me of this circumstance, I certainly would have saved him the trouble he has taken. As for the way in which the mistake originated, although it could be easily explained ; yet, as the recollection of this gentleman and of his friend



friend Dr. Rollo, in regard to the conversation that passed at the time, differ somewhat from mine, I choose to avoid the discussion of a question that rests on the memory of the parties.

Besides, the mistake once corrected, the public have no farther interest in it, and the person concerned almost as little. It did not in the least affect the merit of the experiment, whether it was made in one way or the other; and it is equally evident that I could have no object in view, or purpose to serve, in misrepresenting it.

I have the honour to be, Sir, your obedient servant,

JAMES CARMICHAEL SMYTH.

Charlotte Street, Bloomsbury,

June 16, 1799.

## INTELLIGENCE,

AND

## MISCELLANEOUS ARTICLES.

### *LEARNED SOCIETIES.*

#### DENMARK.

**T**HE Society of Agriculture at Copenhagen has proposed three prizes, to be paid by the admiralty, one of five hundred, one of a hundred, and one of fifty rix-dollars, for the best paper on the rearing of timber proper for ship-building. The points respecting which the society wishes to be informed are: 1. What soil is best suited to the different kinds of wood, and what care is required in the cultivation of them? 2. Can the necessary form and degree of flexion be by any means given to the timber without injuring it? 3. What is the proper time for cutting the trees? 4. Is it

beneficial to bark the trees before they are cut, and in what manner is that operation to be performed? The answers to these questions must, as far as possible, be confirmed by experiments. If the author supports any of his observations on the authority of foreign publications, he must be careful to refer to them in a marginal note. The papers may be written in Danish, German, French or English, and must be transmitted to the Society before the month of October next.

#### GERMANY.

The following question in economics has been proposed by the Royal Society of Gottingen: Has inoculation of the small-pox in sheep been attended with any real utility? does it secure them against infection? and what rules are to be observed respecting it? The Society wishes that the answers to this question may be confirmed by undoubted experiments.

The prize is twelve ducats, and the papers must be transmitted to the Society before the month of September.

#### PROCEEDINGS OF THE INSTITUTE OF CAIRO.

*Frimaire 1, Seventh Year. [Nov. 22, 1798.]*

A memoir by C. Corancez was read, in which the author examined the means of remedying the alteration in the movement of watches, occasioned by changes of temperature. He proposed, for this purpose, that the balance should be composed of different metals; and he examined by calculation what ought to be the form of the parts to render the *vis inertiae* constant, while the oscillating mass dilates or contracts.

C. Savigny read a memoir on the natural history of Egypt, with an enumeration of the different species of animals hitherto observed in Lower Egypt, and particularly insects. He pointed out also some of the causes which may have contributed to reduce the number of these species.

C. Sucey proposed the appointment of a commission for the purpose of collecting information from the inhabitants of countries adjacent to Egypt, which might then be at  
Cairo,

Cairo, and in particular respecting the course of the upper part of the Nile, and the natural and civil history of Abyssinia.

*Frimaire 6. [November 27.]*

C. Levassieur, director of the artillery and marine at Alexandria, transmitted to the Institute a memoir on the different processes proper to correct certain faults in various kinds of iron and steel.

C. Say proposed that different pieces of coin, found in digging among the ruins of Bellecis, should be deposited in the library.

*Frimaire 11. [December 2.]*

C. Hybert, captain of the 85th demi-brigade, sent to the Institute an allegorical drawing made in honour of General Buonaparte.

C. Desgenettes, in name of a commission, gave in a report on the ophthalmia presented by C. Larrest, surgeon general to the army.

C. Monge read some observations he had made on the phenomena of capillary tubes.

*Frimaire 16. [December 7.]*

C. Balzac, architect, presented a poetical piece on the relative situation of the French in Egypt.

C. Berthollet read a paper on dyeing cotton and linen with the carthamus. Egypt supplies Europe with the carthamus, and it is used there for dyeing silk. In Egypt it is employed in the dyeing of cotton, and the process consists, 1. In separating, by means of a water a little alkaline, the yellow part from the red substance. 2. In incorporating the alkali under the grinding-stone with the carthamus. 3. In keeping the heat of the bath at the temperature of from 30 to 40 degrees [of Reaumur, we suppose].

C. Levassieur's memoir on correcting the faults in certain kinds of iron and steel having been referred to a commission, a report on that subject was read by C. Descoftils. Iron which breaks when forged cold is a mixture of two metals,

one

one of which is more fusible than the other; and it cannot be forged but when both metals are softened by the action of heat, or when they are both cold. C. Levassieur pointed out therefore several methods of correcting cold short iron, whether its defect arises from the steely quality it has retained, or from the presence of phosphorus. The means employed by the author to remedy the too great hardness of steel and steelified iron, were by subjecting them to cementation with oxygenated substances.

C. Buonaparte communicated to the Institute an account of the number of persons, inhabitants of Cairo, who had died in the course of a hundred days. The number was 1076, comprehending only Mussulmans.

C. Monge announced, that it appeared from observations made lately at Cairo by C. Beauchamp, that the declination of the magnetic needle was  $12\frac{1}{2}^{\circ}$ .

*Frimaire 21. [December 12.]*

C. Regnier presented to the Institute, from his brother General Regnier, specimens of rock detached from a hill called Djebel Nabo. C. Berthollet and Descoftils were charged to examine the nature of these specimens.

C. Frank, physician, transmitted to the Institute a paper respecting the art of the ophiogenes. The author had frequent opportunities of observing, in different parts of Egypt, the confidence and address with which certain inhabitants of that country handled serpents; and his remarks on this subject will serve to illustrate the accounts given by travellers of the arts employed by these people.

*Frimaire 26. [December 17.]*

C. Fourier presented to the Institute a second part of a treatise entitled *Researches in regard to Mechanics in general*.

The secretary read a poetical composition on the death of a young French soldier, who had been taken by the Arabs soon after the arrival of the army in Egypt.

C. Ripault,

C. Ripault, librarian, presented a memoir, entitled *Recherches respecting the Oasis*.

ROYAL SOCIETY OF LONDON.

Since our last report papers on the following subjects have been read at the meetings of this learned body:—

On a new Principle in Tanning, by George Biggin, Esq. From the experiments adduced in this paper it appears, that elm bark is the least powerful of any, and that oak bark in winter is not so powerful as in spring in the proportion of 30 to 128.

On Lime employed for manure by Smythson Tennant, Esq. This paper contains much useful practical information respecting the effects produced by different kinds of lime-stones. One kind, found near Doncaster, proves highly detrimental to the land on which it is laid, however sparingly, so as to destroy almost entirely all vegetation: this mischievous property is found to be owing to the presence of a portion of magnesia. Near Ferry-bridge, on the other hand, a lime-stone is found which proves highly fertilizing applied in any quantity. This paper is accompanied with a table of different pernicious lime-stones found in various parts of the kingdom.

The reading of a paper on the Decomposition of Borax by Professor Crell, and an interesting one on Shells and Bones, by Charles Hatchet, Esq. terminated the session, which was closed on the 13th instant.

AEROSTATION.

Several of the foreign journals have announced an invention of Professor Danzel for directing an air balloon through the atmosphere. The following is a short account of the method. M. Danzel has constructed two cylinders or axes, to the ends of which are fixed, in the form of a cross, four sails or oars, moveable at the point of their insertion into the cylinder, in such a manner that, when made to move round by means of a handle, the eight oars, like the cogs of a water-

mill

mill wheel, present in succession to the air sometimes their flat side and sometimes their edge.

To cause each oar to turn back on itself about the fourth part of a circle, M. Danzel has not only left sufficient play at the point where the stick of each oar is inserted in the cylinder, but has placed the stick in such a manner that the air itself makes the oar fall back, at each turn, with the necessary velocity and precision. It must here be understood that the two cylinders, armed with their four oars or sails, are destined to occupy one each side of the balloon, four oars on each side.

It is well known that aërostation has a resemblance to flying or swimming rather than to sailing, since every aërostat is immersed in the air as a bird, or as a fish is immersed in water; whereas the effort of a vessel is divided between two elements, one of which, the water, gives it a great point of support, and the other, the air, is very easy to be divided. But the aërostat being totally immersed in the air, it was necessary to find out a movement which, though circular, should not destroy at each half turn the effect of the preceding one; for, the resistance being equal in the whole circumference, it is evident that the support must be diminished or even annulled, if possible, in one half of the circle, and be retained full and perfect in the other. This M. Danzel has effected, by presenting to the air sometimes the edge and sometimes the flat part of the sails on each side, in turns and with great regularity. The result is, that during a continued rotation each cylinder produces a strong current of air behind, and rarefaction before; and this current, which continues without intermission, is very sensible. It is evident then that a body suspended in air at rest, if these two cylinders are attached to it, must advance towards the rarefied space occasioned by their rotation, and produce a continual current of air behind it.

The cogged wheels of water mills being half in the water and half in air, the co's may be immoveable, because at  
each

each half turn the force of the water overcomes the resistance of the air, in the proportion of a thousand to one; but if the wheel with its immoveable cogs were entirely immersed in a current of water, it is evident that it would not turn at all, because the water would make two efforts in opposite directions on the upper and lower cogs. If we now suppose such a cogged wheel totally immersed in stagnant water, and that by means of any power it is made to turn on itself, it will only agitate the water without producing a current; and if it be free to advance or recede, it will do neither. But if the cogs are rendered moveable by M. Danzel's method, in such a manner that the wheel presents alternately at each half turn the flat side and the edge, it will necessarily advance, and occasion a current of water behind it.

## NAVIGATION.

M. Danzel has invented also an hydraulic machine for making a ship or boat advance during a calm, and even against a current. The mechanism of this machine is extremely simple; and if we did not know that the simplest means are often discovered the latest, we might be surprised that it should not have been found out before. It consists of a long pole, to the anterior extremity of which an apparatus, shaped like a drawer without back or front, is attached in such a manner that when pushed forwards it folds itself back under the pole, to which it as it were adheres, and presents to the water the thin cutting surface of its three edges, viz. of the bottom and two sides, which can neither oppose to the water a resistance capable of preventing the pole from penetrating farther, or of making the ship recede.

When the pole, which is pushed forwards from the vessel, has attained to its full reach, the drawer as soon as the pole is pulled back assumes a vertical position, and presents to the water its whole cavity. By these means it embraces a column of water, which, without finding means to escape, presses on

a surface much larger than that of a common oar, and keeps the drawer immoveable; so that those who draw the pole towards them, instead of making the vessel to recede, cause it to advance. This machine, which may be multiplied more conveniently than oars, has this visible advantage over the latter, that it opposes to the water a resistance infinitely superior, while the passive re-action of this resistance renders the labour of the mariners less laborious and more effectual.

#### METEOROLOGY.

The following note has been lately published by Delalande in one of the French Journals:

“ M. Von Zach, director of the observatory of Gotha, the most celebrated and most useful astronomer of Germany, and whom I visited last summer, informs me, in one of his letters, that on the 25th of December he saw the thermometer at  $21^{\circ}$  Fahr. below  $0^{\circ}$ . In the duchy of Wirtemberg it was at  $24^{\circ}$ , at Augsbourg  $25^{\circ}$ , at Mannheim  $19^{\circ}$ , at Vienna  $18^{\circ}$ , at Amsterdam  $16^{\circ}$ , at Dresden  $4^{\circ}$  as at Paris; but at Copenhagen, which is much farther north, it was only at 10 degrees. Thus the cause of this great cold did not come from the north, but probably from Siberia and Tartary. I am accused of having predicted that the winter would be *moderate*. This is not correct. Some weak person had said, in one of the Journals, that every 400 years the winter was severe, and that the last one corresponded with that period. I replied, that the period of 400 years had no foundation; and that, if there were any probable means of foretelling any thing, it would be by the period of 18 years: it has succeeded sometimes. M. Toaldo asserts, that in Italy it succeeds always; and it was this which promised us a moderate winter. On this side the Alps, and the Pyrenees, local circumstances, which cannot be explained, derange often our calculation and the period. I gave that conjecture therefore only as probability, but it has been improperly considered as a prediction.” LALANDE.



## INOCULATION OF SHEEP.

It appears that the practice of inoculating sheep for the small-pox is now common in Germany. We are informed that a M. von Hofman caused this operation to be performed on his whole flock, and that not one of them died. A scratch was made in the skin of the right hind leg, three or four inches from the hoof, and a small drop of matter squeezed from a ripe pustule was rubbed into the wound. A plaster an inch and a quarter long, and an inch broad, was then applied over it. Professor Beckmann, to whom we are indebted for this article, says he does not know whether it has been proved by experience that sheep inoculated in this manner are secured against future infection. This point indeed does not seem to be yet determined; otherwise, the Royal Society of Gottingen would not have made it the subject of a prize question.

## DEATHS.

On the 16th of February, at Munich, of a stroke of the apoplexy, Charles Theodore, elector Palatine, who as a friend to the arts and sciences deserves a conspicuous place in the annals of literature. A chronological catalogue of his institutions may be found in F. P. Wundts *Essay towards a general History of the Palatinate of the Rhine*. In the year 1763 he founded the Academy of Sciences at Manheim, which since its establishment has certainly been of great utility by its researches into ancient history and geography. At the same time that the Academy was founded, a Cabinet of Antiquities was begun. In 1769 the Physical Economical Society at Lautern was established; and in 1774 the High School, which in 1784 was transferred to Heidelberg and united with the University of that place. The German Literary Society at Manheim established in 1775 was founded also by this Prince, as well as the Cabinet of Natural Curiosities begun in 1765; the Botanical Garden; the  
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Military Anatomical Theatre; the Chirurgical College; the School of Midwifery, and the School for attending on the Sick. He augmented the Court Library at Manheim with the scarcest and most valuable works; expended considerable sums on the Observatory of that city, and raised it to be one of the first not only in Germany but in Europe. To encourage and promote the fine arts, he established in 1775 the Academy of Drawing and Sculpture at Manheim, a Hall for copying Paintings with a valuable collection of pictures, and the German National Theatre, which, by the zeal of M. von Dalberg and the talents of excellent performers, soon became one of the most celebrated in Germany.

On the 2d of April, at Lizieux in Normandy, Charles Lemonnier, the oldest of the contemporary French astronomers. He was born on the 20th of November 1715, and had a great share in the expedition undertaken in 1735 for measuring a degree of the meridian in the north.

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TO THE EDITOR OF THE PHILOSOPHICAL MAGAZINE.

SIR,

IN a collection of minerals in my possession there are several specimens which I suspect to contain Mr. Klaproth's new semi-metal uranite; but as they are handsome, and not large, am unwilling to sacrifice them to analysis to know their contents.

If any of your mineralogical readers can, through the channel of your useful Magazine, point out by what means the presence of uranite can be ascertained in such small pieces only as can be detached from cabinet specimens, I shall be much obliged to him.

By giving this a place in your next Number, you will oblige one who wishes every success to the Philosophical Magazine.

June 15, 1799.

A. B.

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THE

PHILOSOPHICAL MAGAZINE.

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JULY 1799.

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- I. *On the Longitudinal Vibrations of Strings and Rods, with Observations on the Conveyance of Sound through solid Bodies.* By Dr. CHLADNI of Wittemberg\*.

PHILOSOPHERS formerly were acquainted only with the longitudinal vibrations of the air in a sounding pipe, where, as is well known, the pipe or tube itself is not the sonorous body, but the column of air contained in it, which, according to the direction of its length, contracts and expands in various ways. That solid bodies also can vibrate in the direction of their length, according to the same laws, as the above elastic fluid in a pipe; and that the laws of this longitudinal vibration are totally different from those of transversal vibration, I first shewed in regard to strings in my discoveries respecting the Theory of Sound†, and in regard to rods in my work on the Longitudinal Vibrations of Strings and

\* Extracted from his work on that subject, entitled, *Ueber Longitudinalschwingungen der Saiten und Stäbe. Nebst beygefügten bemerkungen über die Fortleitung des Schalles durch feste Körper.*

† Entdeckungen über die Theorie des Klanges, p. 76. See also *Berliner Musikalischen Monatschrift.* August 1792.

**Rods.** A string can extend and contract itself either wholly in the direction of its length, or divide itself into two, three, four, or more parts, each of which is subject to a movement of the like kind. The tones, which in comparison of the transversal tones are exceedingly high, are to each other as the numbers 1, 2, 3, 4, &c., or as the number of the vibrating parts. They so far correspond with the transversal tones, that in the same kind of vibration they are in the inverse ratio of the length of the strings; but totally differ from them in this, that the thickness and extension of the string are of no account, and that, for this reason, more depends upon the nature of the substance. Thus the tone of a brass string is about a sixth or a seventh higher than the tone of a cat-gut string; and the tone of a steel string is a fourth or nearly a fifth higher than the tone of a brass string. On the other hand, in the transversal vibrations of a string, the tone, as is well known, does not depend on the quality of the substance, but on the length, weight, and degree of tension. A string, therefore, which vibrates longitudinally, is not to be considered so much as a thread-like body rendered elastic by tension, but as a piece of matter extended in length, and which vibrates exactly in the same manner as a rod or staff fastened at both ends. When a staff is free at both ends, in its first manner of longitudinal vibration, there is a certain point in the middle at which the vibrations of each half stop; in the next there are two, each at the distance of a fourth part from the end; and in the following there are three, &c. The tones correspond with the natural series of the numbers 1, 2, 3, 4, &c. If a rod be fastened at one end during the first kind of longitudinal vibration, the alternate expansion and contraction of the whole rod take place in such a manner that they stop at the fixed end; in the next tone there is a resting point at the distance of one-third from the free end; and in the following there are two, &c. The tones correspond with the numbers 1, 3, 5, 7, &c., and the first of these tones is an octave lower than the

the first tone of the same rod when perfectly free. All kinds of longitudinal vibrations can be best produced by proper friction or rubbing in the direction of the length with the finger, or any soft substance rubbed over with pounded resin, and on glass rods, of which those used for thermometers and barometers are the fittest, with a wet rag bestrewed with fine sand; from which it is evident that the rubbing must be performed within a vibrating part, and that the rod must be gently held between two fingers of the other hand at any of the resting points, but at no other place. In pipes the higher tones are produced by a stronger and somewhat different method of blowing. In a pipe open at both ends, the column of air contained in it vibrates like a rod free at both ends; and the column in a pipe close at one end, like a rod which is fixed at one end. In all longitudinal vibrations, the tones, during the same kind of vibration, depend merely on the length of the sonorous body, and on the quality of the substance: the thickness, and other circumstances in regard to form, are of no consideration. I have examined every substance which I could obtain in a sufficiently long rod-like form, in regard to longitudinal vibration; for example, many kinds of wood and metal, also glass, whalebone, &c. The specific gravity makes no difference; for fir-wood, glass, and iron, give almost the same tone, as also brass, oak, and the shanks of tobacco-pipes made of clay.

As sound is conducted also by longitudinal vibrations, since a portion of air, or of any other substance, is obliged by the impulse of the sonorous body to contract and again expand itself, a more accurate knowledge of longitudinal vibration may serve to determine with what velocity sound is conducted through hard bodies. Count Giordano Riccati, in his excellent work on Strings or Elastic Fibres\*, has proved that sound passes through a space filled with air, of a given length,

\* *Delle Corde ovvero Fibre Elastiche.* Bologna, 1764. 4. Sched. v. § 3. and Sched. viii. dist. 1.

in the same time that a column of air of the same length, contained in a pipe open at both ends, makes one vibration. Newton in his *Principia* \* says the same thing in another manner, for he asserts that each stroke (*pulsus*) passes through twice the length of an open pipe; but he calls a double vibration, that is, a contraction and expansion, a stroke; whereas Riccati and others, agreeably to the common mode of expression, call each contraction, as well as each expansion, a vibration. The principles on which this proposition depends, seem to be of such a general nature that they may be applied to hard bodies; and thus we may at least admit, with the greatest probability, that sound passes through every body in the same time in which that body, when it vibrates freely, makes one longitudinal vibration. We are taught by experience, that sound moves through the air with a velocity of about 1040 Paris feet in a second; we learn also from experiments and calculation, that in a shut pipe of five feet, and an open pipe of ten feet, 100 vibrations are made in a second. According, then, to the above proposition, sound must pass through ten times a hundred, that is, 1000 feet in a second. That the velocity is somewhat greater, being about 1040 feet, does not however contradict the proposition; for the column of air actually agitated by the sounding of a pipe, is always a little longer than that contained in the pipe; as Count Riccati has proved in the before-mentioned work, and as people may be easily convinced through experience, by holding the hand close to the mouth of a pipe, where the vibration of the air will be strongly felt. Hard bodies, if the above proposition be universally true, must conduct sound with greater velocity in proportion as the tone is higher, which is emitted by the same length and with the same kind of longitudinal vibration. Now the tones of a rod of tin are about two octaves and a large seventh higher; one of silver, three octaves and a whole tone; one of copper, nearly three octaves and a

\* *Princ. Philos. Nat. lib. ii. prop. 50. in schol.*

fifth; and one of iron or glass, about four octaves and a half tone higher than the column of air in an open pipe of the same length. If one therefore had a sufficiently long series of such substances, the velocity with which sound is conveyed through tin would be found to be 7800, through silver 9300, through copper 12,500, through glass and iron 17,500 Paris feet in a second. The kinds of wood I have examined would conduct sound from about 11,000 to nearly 18,000, and burnt pipe clay from about 10,000 to 12,000 feet in a second.

Professor Wülfch, in some papers which he read before the Academy of Berlin\* in 1788 and 1789, made known experiments to which he was led by Hook's Micrographia, and from which he infers, that sound moves with infinite velocity through hard bodies, or with the same velocity as light. It follows, however, from the experiments which were made with a series of wooden laths not of considerable length, that sound was conducted through these sooner than through the air.

Hard bodies, in regard to the strength with which they convey sound, seem to exceed air; so that we may consequently admit that air, though the most common conductor of sound, is however one of the worst conductors of it. If a man holds one end of a stick in his teeth, and applies the other to a sounding body, he will clearly hear the sound of it though his ears be stopped; and in this manner two persons, almost deaf, could hear all the notes of my euphon†, even in pianissimo‡. If one holds between the teeth a thread, to the  
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\* Berlin 1793-4.

† For an account of the Euphon see Phil. Magazine, Vol. II. p. 391.

‡ About fifty years ago a merchant at Cleves named Jorissen, who had become almost totally deaf, sitting one day near a harpsichord while some one was playing, and having a tobacco-pipe in his mouth, the bowl of which rested accidentally against the body of the instrument, he was agreeably and unexpectedly surprised to hear all the tones in the most distinct manner. By a little reflection and practice he again obtained the use of

end of which is suspended a large silver spoon, and beats it against any thing, he will hear a noise, even if his ears are shut, equal to that of a large bell. Perolle has given excellent observations on the capability of hard bodies to conduct sound, in the Memoirs of the Academy of Turin for 1790 and 1791. Articulated tones also are conducted exceedingly well through hard bodies, as I found by experiments which I made with some of my friends. Two persons who had stopped their ears could converse with each other when they held a long stick, or a series of sticks, between their teeth, or rested their teeth against them. It is all the same whether the person who speaks rests the stick against his throat or his breast, or when one rests the stick which he holds in his teeth against some vessel into which the other speaks. The effect will be greater the more the vessel is capable of a tremulous movement. It appeared to be strongest with glass and porcelain vessels; with copper kettles, wooden boxes, and earthen pots, it was weaker. Sticks of glass and next fir-wood conducted the sound best. The sound could also be heard when a thread was held between the teeth by both,

this valuable sense, which, as Bonnet says, connects us with the moral world; for he soon learned, by means of a piece of hard wood, one end of which he placed against his teeth, while another person placed the other end in the like manner, to keep up a conversation, and to be able to understand the least whisper. His son made this beneficial discovery the subject of an inaugural dissertation under the following title: "*Dissertatio medica sistens novi methodi surdos reddendi auditentes physicas et medicas rationes.* Præf. ANDR. EL. BUCHNERO; auct. JO. JORISSEN. Halæ, 1757. 4. One hears most distinctly when the end of the stick rests against the upper fore-teeth; or rather when it is held between the teeth: if placed only against the lower teeth, it will be of no avail. The natural causes of this and many other variations which the author and his father tried, are explained in the above useful Tract, which was afterwards published in German, by the president, with the title of, *Büchners Abhandlung von einer besondern und leichten art Taube hörend zu Machen: Nebst andern Anmerkungen.* 1re Samml. Halle 1759. 8.—[This note is by Professor Blumenbach. EDIT.]



so as to be somewhat stretched. Through each substance the sound was modified in a manner a little different. By resting a stick or other body against the temples, the forehead, and the external cartilaginous part of the ear, sound is conveyed to the interior organs of hearing, as will readily appear if you hold your watch to these parts of another person who has stopped up his ears. From this it appears, as well as from many known experiments made in regard to hearing under water, that in most of our books on the elements of physics, in which in general acoustics have had the undeserved fate of being treated in a much more imperfect manner than other parts of philosophy, sound is very improperly considered only as a vibration of the air, and the theory of it referred to the head of Air. Hearing is nothing else than, by means of the organs of hearing, to be sensible of the tremulous movement of an elastic body, whether this tremulous movement be conveyed through the air, or any other fluid or hard body, to the auricular nerves. It is also essentially the same whether, as is usually the case, the sound be conveyed through the internal part of the ear, or whether it be communicated through any other part of the body. It certainly would be worth the trouble to make experiments to try whether it might not be possible that deaf and dumb people, when the deficiency lies only in the external organs of the ear, the auricular nerve being perfect, could not, by the above method of conducting sound, be made to hear distinctly words articulated as well as other sounds.

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## II. *Observations on the true Origin of the Gossamer.*

By J. M. BECHSTEIN\*.

TO explain the origin of the gossamer is an old problem, which, after a number of experiments, no one, as far as I know, has yet fully solved. Some naturalists have considered

\* From *Magazin für das Neueste aus der Physik*. Vol. VI. Part I. p. 53.

this phenomenon as the evaporation of plants condensed during the cool days of harvest by the air, and converted into threads like those which can be drawn from resinous juices; others, as the production of a kind of spider, on account of its similarity to the threads of common spiders\*: and M. D. C. Pereboom has lately discovered a kind of beetle furnished with a vesicle on its back, from the hinder part of which, on both sides, proceed two threads that extend over the extremity of the body, and end in a double thread, sometimes ten or more ells in length; and this thread is supposed to be what is commonly called the Gossamer.

After many years experience and observations made almost daily when this phenomenon appeared, I flatter myself that

\* In the country, during autumn, certain threads are seen hanging from the trees, or extended on the bushes, and even the grass, which, when agitated by the wind, detach themselves from the branches, are transported to others, and are joined or separated at the pleasure of the breeze. People in walking often find their faces, hair, and clothes, covered with them. They are generally called the threads of St. Martin (*filets de St. Martin*), because it is about St. Martin's day that they appear in the greatest abundance. When the moisture of the atmosphere and the dew attach themselves to these threads and become congealed, so that the threads appear thicker and whiter, the peasants call them the hair of the Virgin Mary (*cheveux de la Vierge Marie*). Having one day asked them the cause of this production, they unanimously replied, and without variation, that it was the vapours of the earth, which at that season are thicker and denser. I had no great confidence in this opinion: but I soon learned the real truth; for, being in a field overspread with heath in the time of autumn, I observed that almost all the heath-bushes were covered with spiders webs, and when these were opened I found inclosed in each a spider. These spiders were small, of a red colour, and marked with spots; their feet were short, and the head was large in proportion to the belly. Such spiders webs are found among the low shrubs that grow near the earth, at the bottom of stalks of corn which have been left standing by the reapers, and in the bushes. When the wind is strong it breaks these webs, carries away a part of them, which are scattered over the ground and the trees, and hence come the threads of St. Martin. *Huctiana*, Amsterdam 1723, p. 369. EDIT.

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I am able to resolve the problem respecting its origin. In my opinion the gossamer arises from nothing else than a certain kind of field-spiders, which are, however, so small and active, that they almost always escape notice, unless the observer is endowed with great acuteness of sight. I would call this spider, if it has already no name, the gossamer spider (*aranea obtextrix*): I shall here give a short description and history of it, as far as my knowledge extends.

The gossamer spider (*aranea obtextrix*) is as large as the head of a small pin. On the fore-part of its longish head it has eight grey eyes placed in a circular form; the extremity of the body is shaped like an egg; the body itself is of a shining dark-brown colour; the feet are of a moderate length, and yellowish; and the whole animal is covered with insulated hairs.

These insects first appear in the beginning of October, in woods, gardens, and meadows, where their eggs may be hatched unhurt and unmolested, and thence spread themselves over whole districts, so that during all the month of October and till the middle of November they may be found on the dry fields throughout all Europe; and as they produce a numerous progeny, extensive tracts may sometimes be seen swarming with them. The young, which have not attained to their full growth, are not larger than the point of a pin; they are black, with grey feet, and almost imperceptible to the naked eye. In the beginning of October, when very few of them have been hatched, one observes only in the sunshine a few single threads of their webs, which they extend from twig to twig, or from straw to straw; but about the middle of the month their threads become more perceptible; and towards the end, if people stand or place themselves in such a position that they can see the sun-beams playing on the tender threads, they perceive hedges, meadows, corn-fields, stubble land, and even whole districts, covered with a fine white thick sort of gauze. This spider belongs to that kind which do not weave webs, but only extend single threads

threads from one place to another, and which Linnæus, on that account, includes in a particular division. The threads, owing to the smallness of the animal, are so delicate that a single one cannot be distinguished by the naked eye unless when the sun shines upon it. A thread, to be visible at other times, must be composed of at least six threads twisted together; and such a thread, as the single ones are exceedingly brittle and do not readily unite, may be again easily divided into its component threads. During the serene calm days of the above months these animals carry on their occupation with great diligence, especially after the morning fogs have disappeared. Between the hours of twelve and two, however, is the period when their great industry excites most admiration. If people are possessed of good eye-sight, or are furnished with a magnifying glass, they may find among the barley stubble such a multitude of these spiders employed in extending their threads, that the fields appear as if covered with swarms of gnats, and they perform their labour so speedily that they seem to fly from one stubble to another.

These tender threads, which are extended over whole fields, particularly in the last half of October, become twisted together by the gentlest breath of wind, and form perceptible threads, that, being broken loose by a stronger wind, are united into thick threads, and even balls, that float through the atmosphere. They are known then in Germany by the name of the *flying summer*\*, because the summer seems as it were to fly away at the same time. The spiders also are then conveyed along in them; and it is not uncommon to find these animals entwisted in such threads which have been caught †,

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\* In German *fliegende sommer*.

† A singular use which some kinds of spiders make of their webs is, that they serve them instead of carriages to perform long journies, and to transport themselves from one country to another. At certain times of the year we may generally see, when the sky is serene, a multitude of strong threads and balls formed of the threads of these insects, floating about in the atmosphere;

All the spiders, however, found in these threads or balls, must not be considered as the animals by which they were prepared; for other kinds of spiders, common in harvest, are sometimes entangled in these threads and carried along with them. Thus, for example, the black and white spotted tree-spider, and the so called chestnut-spider, are often found inclosed in the gossamer together with their habitations, and must obey the impulse of the winds.

These webs, which consist of threads closely joined together, serve the insects as nets, in which they catch very small black flies, gnats, and winged tree-lice, the juices of which they suck for their nourishment. The gossamer, therefore, is often found filled with the dried husks of such insects.

The above, in my opinion, is the real origin of the gossamer. But why do these spiders appear only in the time of harvest? why not earlier? and why are they not found like the house and field-spiders throughout the whole summer? —These objections obviate themselves. They appear at that period for the same reason that may-bugs (*moykaffer*) appear in the month of May. They are as necessary in their order to preserve the equilibrium of the balance of Nature as the may-bugs are in May. Single spiders of this kind, however, may be found the whole summer through, as single may-bugs are found in harvest. To those who know that exactly about this time those birds, for whose nourishment insects have been assigned, undertake their emigrations, and that the larks in particular, which are so fond of spiders, then leave us, the above phenomenon will not appear wonderful, but will rather be considered as a wise regulation of Nature. Those who wish to be convinced of the truth of this observation need only to shoot a lark at that period and to open it imme-

sphere; and when these threads and balls are examined, they will always be found to contain spiders, which have prepared these substances to enable them to fly without wings, and to procure themselves an easy passage to other countries. *Tôcologie des Insectes par Lefser, avec des Remarques de P. Lyonnet. A la Haye, 1742. Vol. I. p. 346. EDIT,*

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diately. These insects, together with the grains of barley which drop from the ears, must indemnify these birds, which stop in many places on their passage in great numbers, for the loss of the summer insects.

After what has been said, I do not think that the whiteness of the threads, which arises from nothing else than the dews that fall at that period, or their clamminess when rubbed between the fingers, not observed in the threads of other spiders, and which is occasioned by the fineness of the threads, that so easily insinuate themselves into the cavities of the skin, can be brought as any objection against this mode of explanation. These phenomena can have no weight unless we ascribe these threads to the common spider. It is likewise very improbable that the gossamer is produced, as M. Pereboom asserts, by his beetle; which however must excite our admiration, because, like the spider, it weaves for itself a net, either to serve it as a habitation, or as the means of catching its prey.

III. *Remarks on Mr. SHELDRAKE'S Dissertation on Painting in Oil in the Manner of the Venetians. By Mr. EDWARD DAYES. Communicated by the Author.*

**P**ERSUADED that Mr. Sheldrake labours under a mistake, which may lead others into a practice difficult in itself and dangerous to the durability of their works, I shall offer no apology for the following remarks on his Dissertation\*.

That the Venetians primed with distemper, is true; but the colour used was not a *brown*, as stated by Mr. Sheldrake, but a *red*, known at present by the name of *Venetian red*. Some artists at this time employ the same colour, previously calcined, in a new Venetian method: I say a new one, for there are two or three. One of the secrets consists in prim-

\* See Phil. Mag. Vol. II. p. 302.

ing the cloth with bone-ashes, mixed with a small quantity of size or paste, and afterwards brushing it over with the above calcined-red.

The method of working up the picture in a state of black and white was certainly practised at times by some of the Venetians; but in that case the ground was no object, as the whole effect of colour was afterwards acquired by glazing: this is observable in the pictures of Tintoret, and sufficiently accounts for the perished state they appear under. On the contrary, where the red ground was used, the light and extreme dark are the only part where the colour lays in a body. Mr. Sheldrake observes, he does “not pretend to degrade painting to the rank of a mechanical art, that may be infallibly practised by a receipt.” If the Venetians had possessed no higher recommendation to notice than mere colouring, they would not have so strongly arrested our attention; on the contrary, the compositions of Titian, Paul Veronese, &c. will ever rank among the first. The present rage for colour is like preferring person to mind, and had it prevailed in the time of Swift, would certainly have procured some of our professors a situation at Lagoda.

The author of the Dissertation must certainly have mistaken the words of Sir Joshua, or not understood them. Sir Joshua could never have said that harmony was to be produced by “an unity of light and an unity of shadow pervading the whole;” or, in other words, (as I understand it,) by reducing the whole of the lights to one colour, as is implied by the word *unity*. Such a practice would destroy the brilliancy which the author wishes to obtain from glazing. The simile afterwards introduced, contradicts entirely such an inference. “A picture, to possess harmony of colouring, should look as if it was painted with one colour; and, when the *chiaro-oscuro* was complete, the colour of each object should be glazed over it.” Sir Joshua was in the simile describing his own practice, and which will, for a short time, produce a greater brilliancy in the light. Instead of an  
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"*unity of light*," the word *harmony* must have been used, as harmony of light and unity of shade are common terms. In note 43, on Du Fresnoy's Art of Painting, he (Sir Joshua) expressly says: "And for the sake of harmony, the colours, however distinguished in their light, should be nearly of the same colour in their shadows, of a

—— "simple unity of shade,

"As all were from one single palette spread."

Every one knows that the harmony of the picture depends greatly on the shadows not being disturbed with colour. That Sir Joshua was acquainted with the method of bringing forward his pictures in a state of black and white, and glazing for the colours even in his draperies, is too true, as is known to all acquainted with his practice, and was, I believe, the reason of their not standing. His method was, with ivory black, vermilion (used in the carnations), and white, to bring forward his pictures to their full effect, and then to glaze for all the colours. It should be observed, that this method might only be practised at times, but I had myself several opportunities of seeing it.

All the advantages obtained by the practice of glazing, as it is called, are so transitory, that they may be literally said to be but the vision of a day. Whether this arises from the gum in what is termed *maguip* \*, (a composition of two parts mastic varnish and one of drying oil,) mostly employed for the purpose, or want of body of colour, I do not pretend to determine, though I think both may contribute to effect their destruction; the colour by flying off, and the gum by

\* The above composition, when mixed on the palette, forms a consistence like honey, with which the colours work exceedingly free. There are various compositions for *maguips*; some using wax dissolved in nut oil, others rosin and sugar of lead in the same solvent, wax in spirits of turpentine, &c.: though I must own a preference for the drying oil and varnish for diluting the colours for the touches or pluming on a part, but for the mere act of glazing I prefer good clear oil.



losing its transparency. One thing I have frequently had occasion to remark in the use of water colours (in a transparent state), that the more gum is mixed with them, the sooner they fly. As far as glazing goes to enrich a colour it is necessary; but that is a very different practice from the one I now speak of.

Many substances employed as pigments give black, or dead, heavy colours; as Prussian blue, indigo, dark lake, and indeed all colours that are transparent when viewed in a lump; but, spread on a white ground, or mixed with any colourless matter, they appear in all their vigour. If, instead of a white ground, a grey or brown is used, the vivacity will be more or less in proportion to its darkness. These facts furnish strong reasons for preferring a white ground, and may account for the darkness in many of the Venetian pictures, from their glazing with transparent colours on a dark surface, and, as before stated, the loss of clearness in the vehicle used (no doubt a gum); but this appears to have been only an occasional practice.

The Dutch painters, whose mechanical excellence was inferior to none, always used white grounds prepared with the greatest care. They spread well-washed chalk mixed with size over the surface to be painted on, which if nicety was required they pumiced, and repeated the operation till the surface was even; after which they laid over it a coat of the finest flake white. The whole picture was then painted fair, (that is, with a body of colour,) except the shades, which were kept clear and transparent, and received an additional lustre from the ground. That this was their practice may be easily seen in all their interior scenes and the close parts of their pictures.

It is much to be wished that, instead of brilliancy, *permanency were sought after*; while the Venetian pictures are going fast to decay, the works of Van Eyck, Quintin Matsys, and John de Mabuse, remain fresh and vigorous.

With respect to shadow being a privation of light, it is

readily admitted, and it equally follows, that it is a privation of colour; but this circumstance shews, as before stated, that much of the harmony of the picture must depend on its not being disturbed with colour. Where Mr. Sheldrake attempts to illustrate this doctrine, by supposing a globe exposed in a painter's room, he seems rather to have confused the matter by too many divisions. Artists divide the surface of all bodies into light, middle tint, shadow, and (which Mr. Sheldrake has forgot to add to his globe, to round it) reflection. There are two things the author of the dissertation appears to have overlooked, and which ease the difficulty of producing the harmony necessary to constitute a whole: first, the method (said to have been at first practised by the Venetians) of breaking the colours, so as to make them all partake in some measure of each other, and which was at times carried to a degree of insipidity even by Titian; and secondly, (and which I think the most essential,) the grouping the warm colours together so as to form a mass, and letting them occupy the greatest portion of the picture. The latter appears to have been the practice of Rubens and others of his school, and which enabled him to introduce the whole scale of colours in the same picture, from the hottest to the opposite extreme of cold; this gives a vigour to his colouring beyond all other masters.

The method of working up the picture in a state of black and white, was certainly never practised by the Flemish masters. The beauty observable in the colouring of Rubens (whose demi-tints are wonderfully clear) resulted from a firmness in the handling, a simplicity and distinctness in the tints, and a particular care to avoid muddling them in using: I do not mean to say they never glazed, or scumbled to give richness; but that was done in a different manner to the one described in the Dissertation. In some of his slight pictures the tones in the flesh may be traced as follows: the light yellow, next the carnations, then the grey, next the shadow, glazed to give it clearness, and his reflections generally very bright;

bright; but in his finished works they are of course more blended. Every artist knows, or ought to know, that there are but three primary colours, red, blue, and yellow; the compound colours, which result from combining these, amount to four, making in all seven. Red and blue, when mixed, produce purple; red with yellow, orange; blue and yellow, green; the three united, a brown, black, or grey, as the warm or cold colours prevail. Those constitute all the colours and tints in nature, mixed with more or less white. The fewer colours used by the artist the better he will colour, from the practice being rendered simple, and the possibility of muddling in some measure destroyed: for, *it is not the mixing colours that hurts, but the mixing many*; two colours will always be clearer than three, and so on. Though the above considerations offer a simple theory of colouring, yet in practice the artist must have judgment enough to acquire at once the precise tint he wants, to insure clearness and brilliancy. The singular fact of white appearing grey on a brown ground, I should suppose to arise from white being cold, and from its contrast with the brown. That a picture painted in brown and white should be in perfect harmony is not to be wondered at, as it can only be termed an effect of light and shade. The brown used by the Venetians has, with great probability, been supposed a preparation of asphaltum.

As the practice of glazing is the last operation in painting, and as in the doing it the artist uses in the shadows some transparent dark colours, it of course follows, those shadows must be kept tenderer to receive the glaze, which may be extended to the demi-tints if kept tender in proportion also: this will produce the deceptive appearance Mr. Sheldrake speaks of in the Venetian pictures, and do away the weight resulting from mixing, as he says, "some dusky colour with the local colours and the light." The above method, with the practice of scumbling on the lights, or

merely enriching a colour by glazing, in my opinion sufficiently accounts for Venetian brilliancy.

What is meant by black and white not being the painter's extreme of light and dark, I profess not to understand: all that I know is, that the artists have to lament, as well as Mr. Sheldrake, the being obliged to represent shadow with a substance, and that even glazing them thin is but a poor imitation of the real appearance. With respect to "the painter's art being to represent objects as they appear, in point of colour, to be not as they really are," I am equally at a loss to understand the author, having ever been taught to consider all colour as comparative; and therefore, that black at 50 feet distance was no longer so, and to call it black would be as absurd as to call twilight night.

If I judge right, (from the author's recapitulation,) there are three stages in his process; first, the darkest tints, then the lights, and lastly the colouring. Now I think it is evident, from the oil being instantly absorbed by the ground, that it would be utterly impossible to blend the lights and darks together so as to make the picture mellow. Then comes the glazing for the colours, which is bad, as experience has sufficiently shewn the want of durability: besides, for such a process, oil makes the colours too thin to work: this made the artists resort to the expedient of using maulp, which has the injurious tendency before stated. What made these artists so desirous of a clearness in the shades, was to give them that non-substantial appearance Nature puts on: in his lights, it is true, the artist wants brilliancy, to acquire which he occasionally glazes or scumbles; but every good artist knows, that the less recourse he has to the former practice, the more permanent his picture will be.

After all the consideration I have been able to give this subject, I am inclined to think that the Venetian method, judging from a picture by Tintoret now before me, was more like that followed by Sir Joshua Reynolds, as above described;

scribed, than the one recommended by Mr. Sheldrake. *Titian glazed on colour, Tintoret often on white*; and I think it will invariably be found, that the works of the latter are more perished than the former. That exquisite lightness attendant on a dead colouring, may, in a great measure, be restored by scumbling.

The plan he has proposed, and which seems to have been resorted to, to remove the practical difficulties he met with, is merely to paint in varnish; a method which always gives brightness for a short time. The objections to its adoption may be summed up in a few words: first, the difficulty of blending the colours used to produce the effect of light and shade; and secondly, (which is by far the most material,) the want of durability in the colours, as they must all be acquired by glazing; not to mention the strong similitude between it and Sir Joshua's method, as above described.

As I never bought Miss Provis's secret, I cannot tell how close the approximation may be between her method and the one proposed by Mr. Sheldrake; but if I may judge from practical experience, they would both be productive of hardness; and as some of the colours in the pictures painted after her method carried evident marks of destruction on them, I was immediately induced to suppose that some calcareous earth was used in the ground\*. Though I much question the utility of Mr. Sheldrake's plan, I think he unquestionably deserves the thanks of the public, and of artists in particular, for the time and trouble he has bestowed on it.

\* Lime and terra ponderosa destroy the colouring matter of Prussian blue; some drawings, hung up in a house that had undergone a considerable repair, lost all their blue colour, which had become a dirty iron grey.

IV. *Progress of Dr. MITCHILL's Mind in investigating the Cause of the Pestilential Distempers which visit the Cities of America in Summer and Autumn. Being a Development of his Theory of Pestilential Fluids, as published to the World in 1795 and the succeeding Years.*

[Concluded from Page 43.]

WHILE these inquiries were making, a memorable dispute was carried on in some of the Atlantic cities, Whether the exciting cause of yellow fever was of domestic origin, or imported from foreign places in ships and merchandize? The prevailing opinion at New-York was, that there were local causes enough for the production of that distemper in the city itself. With the intention of removing the causes of this plague from the town, the Legislature, then sitting at Albany, 160 miles distant, rapidly passed a bill prohibitory of certain trades and manufactures within the compact part of the city. The act forbade, among other things, the *manufacture of soap and candles* under a heavy penalty, except at definite distances from the houses and settlements. The description of citizens engaged in these branches of business presented immediately a memorial to the Legislature for relief on this occasion, and retained Dr. Mitchill as their counsel to manage the business of procuring some terms of mitigation at the seat of Government. In drawing up the argument in favour of his clients, he became more firmly convinced than before, that substances composed of carbone and hydrogene, such as *fat, grease, and oil*, were incapable of yielding pestilential air; and that the substances containing *septon*, to wit, the *skinny, lean, muscular, and membranous* parts of animals, together with the *blood and alimentary fæces*, were the substances whence unhealthy and noxious exhalations proceeded. From a general and broad induction of facts arranged in the argument employed on that occasion, it was rendered clear, that the substances containing

*septon,*

*septon*, and none others, were known to afford pestilential air. The same rule applied to *vegetable productions*, of whatever kind they might be. On this occasion it was exhibited in evidence, that the persons who were engaged steadily among the *ashes*, *soap*, and *fat* of those manufactories were protected as it were from pestilential diseases, and fared mightily better than their neighbours.

A part of this doctrine soon after received confirmation from Count Berchtold's and Consul Baldwin's account of the beneficial effects of *oil* in keeping off and relieving the *symptoms of the plague* in Asia, and from the remarkable exemption of the Nantucket whalers from malignant fevers on their long voyages over every part of the ocean.

From the survey of the facts relative to *alkalis* and *oils*, there could hardly remain a doubt that they acted upon the *acid of pestilence*, by neutralizing or decomposing it: still, if this acid consisted of *septon* and *oxygen* chemically united during the putrefaction of organized bodies, why did not those elementary substances, it was asked, which constitute the bases of azotic and vital airs respectively, incorporate in the atmosphere, where they exist in states apparently very favourable to combination? The reason appears to be, that after *septon* and *oxygen*, in their separate forms, have connected themselves with caloric enough to form distinct gases, they are repelled thereby to distances greater than chemical attraction can reach, and therefore remain separate. This idea, which Dr. Mitchill originally started, has since been confirmed by Citizen Guyton's account of the possibility of bringing the bases of the two airs into chemical union, by compressing them with a force equal to several atmospheres; a part of the caloric in such cases, according to Dr. Darwin's idea, being crowded out after being compelled to quit its hold. Indeed it seemed evident that the chief difference between common air and pestilential air consisted merely in this; that in the former, the *septon* with caloric formed azotic air, and the *oxygen* constituted vital air, each

distinct from the other; whereas in the latter case the septon and oxygene are chemically blended with each other, base with base. The reason of their readiness to unite during the putrefactive process now became evident. The bases of the two airs rushed into union *before* they had attracted caloric enough to turn them to simple gases, and give them the repellency incidental to that condition.

The venomous and deadly qualities of nitrous acid had been ascertained by Eaglesfield Smith in his experiments upon small animals inoculated with it.

A case occurred during Dr. Mitchill's attendance as one of the physicians of the New-York Hospital, where *fever* appeared to have been brought upon a patient by the nitric acid absorbed from the decomposition of a large quantity of red precipitate with which an ulcerated leg had long been dressed.

Several instances had come to his knowledge, of severe disorder in the alimentary canal, terminating in *dysentery*, from an accidental drinking of diluted aquafortis.

It immediately struck him, that privies and collections of human ordure had been long noted for containing septic (nitric) acid. The effluvia of privies had in several instances been known to excite dangerous sickness. Many of the articles of diet contained septon; and oxygene, in some form, always existed in the alimentary canal. As the contents of the stomach and intestines were inanimate, it was exceedingly probable that, in certain cases of indigestion and costiveness, septic acid might be formed in the cavities of these abdominal viscera; and that irritation and inversion of the motions of the stomach, in some forms of *yellow fever*, as well as spasms of the colon, griping pains and tenesmus in some of the cases of *dysentery*, PROCEEDED FROM THE SAME EXCITING CAUSE.

By an induction of facts from the operation of *neutral salts* in these kinds of distempers, it appeared, that the most efficacious and salutary were those which are capable of decomposition



composition by *septic acid*, if it existed in the intestines; and that really, besides their cathartic effect, they possessed a power, derived from their *alkaline bases*, to neutralize that mischievous and tormenting liquid. From this principle Dr. Mitchill investigated a theory of the *modus operandi* of these numerous and important articles of the MATERIA MEDICA.

Frequent instances afterwards evinced the justness of this interpretation; for in the New-York Hospital, as well as in private practice, he found watery solutions of the carbonates of pot-ash and soda to be most excellent anti-dysenteric remedies, and valuable prescriptions in the cholera infantum. The administration of the carbonate of soda in *clysters*, to allay tenesmus, was suggested to Dr. Mitchill by Dr. Lent, then apothecary of the house, and found, on repeated trials, to be a valuable remedy. Dr. Saltonstall has treated of the application of this principle to explain yellow fever, and Dr. Bay to elucidate dysentery, in their several inaugural dissertations published in COLUMBIA COLLEGE.

After being called to the Professorship of Chemistry, Natural History, and Agriculture, in that seminary, Dr. Mitchill delivered these doctrines publicly in his annual course of lectures. The dissertations just mentioned shew with what zeal and success they were discussed and applied by his hearers. And a circumstance worthy of notice respecting both the gentlemen last named, is, that they witnessed and lived through the plagues they have described.

A general inference from all the phenomena was, that these miasmata or contagions, in all their forms herein contemplated, were violent STIMULANTS, as Brown had originally conjectured.

But the application of this doctrine to AGRICULTURE was not much less interesting than its relation to Medicine. Dr. Mitchill was born in the parish of Hempstead, in Queen's County. His father was a landholder, and culti-

vated his own estate, as is common in America. The early part of his life, to the age of seventeen years, was passed in the country. In the way he was educated, the implements of husbandry, and the method of using them, were familiar to him: he knew the management of the plough and of the spade. After the death of his father in 1789, he took possession of the family-patrimony, and lived on it as a practical farmer for several years. His experience and opportunities during this series of agricultural employment, had produced, among other things, a more curious and particular attention to MANURES.

On reviewing his former observations, the subject presented itself to him under several new aspects. The production of *septic acid* among the excrements of animals had been long known: the neutralization and fixation of this was, he thought, one of the principal effects wrought by *alkalies* and *lime*. Instead of saying, with the generality of modern observers, that lime was serviceable by its septic or putrefying quality, (an opinion for which there is no plausible foundation,) Dr. Mitchill became convinced, its principal effect was, to combine with septic acid into calcareous nitre, one of the richest of manures; and reserve this, without volatilization or evaporation, fixed upon the soil, to stimulate and feed the plants which grow there. Thus wholesomeness and fertility were provided for in the same operation. It seemed to him also, that the deliquescent property of the septite of lime enabled it to retain moisture a long time upon the land, and thereby most agreeably secured the crop from the pinching of drought.

It was obvious, that if there was much septic venom (oxygenated septon) in any field, yard, or region, and no lime or alkali to neutralize it, epizootic diseases among cattle might proceed from it, after the manner of epidemic distempers among the human species. Dews and fogs impregnated with septic acid, appeared the probable exciting causes of several mortal disorders in neat-cattle, sheep, and horses; a considerable

considerable quantity of such dilute aquafortis being taken into their bodies as they grazed during the night. He thought this was corroborated by the symptoms related by Lancisi to have been observed in the cattle sick of such diseases in Italy.

And it was no less plain that *rust* and *mildew* in wheat were owing to the same cause.

The unwholesomeness of certain dews, in certain places and times, was evidently, he believed, to be ascribed to a portion of septic acid gas, volatilized during the heat of the day, and precipitated with a portion of atmospheric water in the cool of the night.

With this branch of the enquiry was connected the whole history of nitre, and the pits, beds, and caverns wherein it was produced, whether spontaneously, or by the hand of man. The interpretation of all the facts relative to which amounted to this; that the alkali neutralized the *acid poison of putrefaction*.

On looking around, it could not escape Dr. Mitchill, that the sweetening and cleansing effects of *lime*, *alkaline ley*, and *soap*, in DOMESTIC ECONOMY, were now capable of an easy and complete explanation. The sweat, perspiration, and excreted matter of almost every sort, which rendered clothing, bedding, furniture, and houses foul, contained septon; and consequently, in the heat of the human body, *septic acid* might be produced in quantity and strength sufficient to excite many morbid *affections of the skin*, and, if absorbed, engender the *worst forms of fever*. Lime, ley, and soap rendered the human body, its clothes, bedding, &c. pure and wholesome, by their power of attracting all kind of pestilential matter, and carrying it clean off. He therefore became satisfied that the old maxims of female management were best; for he never knew infection break out where there was a SMART WOMAN for a housekeeper: the reason was, she kept the mischief down by *alkalies*. On the other hand,

hand, wherever MEN, especially those who set up for PHILOSOPHERS, took the lead; as in prisons, workhouses, hospitals, and ships; there were for ever complaints made of the rise and progress of malignant distempers: the reason was, they increased the evil by acid fumigations\*.

Numberless instances had happened in New-York, of persons being *poisoned*, and many of them to death, or, in other words, catching the yellow fever, from the septic vapour of corrupting *beef* and *fish* cured with too small a quantity of salt. These are mostly *lean* animal substances. On their corruption they afford the most deadly effluvia. The frequency of stinking provisions of these kinds, and of the poisonous vapours they emitted, led Dr. Mitchill to investigate a theory of the muriate of soda in preserving animal flesh from putrefaction. The result was this: when septic acid is formed in a barrel of beef, the common salt is decomposed; and while the septic acid combines with the soda, the muriatic acid is set loose to impregnate and preserve the meat. When there is too little muriate of soda, the septic acid, becoming volatile, often sickens, and even kills the persons who are exposed to it.

This interpretation led naturally to an inquiry into the use of the *bile of animals*; which, instead of being a *vile, troublesome, excrementitious*, and *corruptible* liquor, as it has been fashionable to term it, turns out to be a grand preserver of health, by virtue of the *soda which it contains*; being always ready to pour itself into the duodenum, and even regurgitate into the stomach, to neutralize any portion of septic venom which may have been swallowed or engendered there. Of all the fluids the animal body contains, the gall is the least liable to corruption, or alteration unfriendly to health.

\* The author of the present paper was not perhaps aware of the strong evidence in favour of the utility of acid fumigations that has been brought forward by Dr. Smyth, Mr. Cruickshank, and others. EDIT.

There are many more inductions of facts which unite in the establishment of the general principle Dr. Mitchill has investigated. Some of these have been published in America, and some exist still in manuscript. The desire of writing a book seems never to have influenced him. Accordingly he has generally conducted his discussions in the form of letters to his friends and correspondents: and even these he has never collected into a volume; they lie scattered about in magazines and dissertations where they were first inserted. There is a promise, however, of printing the whole in the Medical Repository, where they may in succession be laid before the learned world. In this immense inquiry, it is hoped, he will be assisted by the candour and talents of those scientific inquirers who are now-a-days making such vast discoveries in Europe.

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V. *Account of a Voyage to Spitzbergen in the Year 1780. By*  
S. BACSTROM, M. D. *Communicated by the Author.*

SIR,

HAVING received much gratification from a perusal of your Magazine, I send you a few particulars respecting a voyage which I made to Spitzbergen in the year 1780, extracted from a journal I kept at the time; which you may lay before your readers, if you think they can contribute either to their information or amusement.

<i>The Editor of the</i>	}	I am, &c.
<i>Philosophical Magazine.</i>		
		S. BACSTROM.

A VOYAGE to Greenland, as it is called, though in fact to the island of Spitzbergen, for the purpose of killing the black whale-fish, is one of the healthiest that can be undertaken, and furnishes so much curious matter for amusement to persons of an inquisitive turn of mind, that even a second will hardly satisfy such, if they have been fortunate enough

to

to sail with a good commander, and in a vessel well appointed. In both these respects I was very fortunate, which is rather uncommon; the masters or commanders in the Greenland trade being generally men of little or no education, and consequently void of those liberal sentiments necessary to render the situation of those who accompany them comfortable. If a regularly educated surgeon, from a desire of visiting such northern regions, goes in a vessel under such a person as I have described, he is generally sickened the first voyage; a barber is perhaps his successor, and when any illness or accident happens on board, if the patient escapes with his life, he is often rendered a cripple. I have seen some instances of this kind.

The unfociable disposition of the master is not, however, the only circumstance that often deters from a second voyage. I have known vessels well stored by the owners with every necessary and useful article, and even a liberal supply of what some would call luxuries, and yet every comfort withheld from those on board: the master literally starving himself and officers, and not allowing a bit of fire in the cabin, in these cold latitudes, that he might save a few coals, some dozens of hams and tongues, a quantity of cheese, butter, flour, wine, porter, &c. *to send home to his own family* at the end of the voyage: a paultry theft, at the expence of the health and frost-bitten limbs of those on board.

When the reader is informed that such has been my passion to visit foreign climes that I have been no less than fifteen voyages, one of them round the world, he will not be surpris'd that I should wish to gratify my curiosity by visiting the frozen regions, even though I knew something of the inconveniencies before described, to which those who undertake the voyage are often expos'd. My business was to guard against them as well as possible, by proper inquiries respecting the character and disposition of the master, and I succeeded to my wish in two voyages to these parts: the first was in the Sea Horse in the year 1779, which yielded me  
much

much satisfaction; but I was more completely gratified by the second, which is the one I mean to describe.

I engaged myself as surgeon on board the *Rising Sun*, William Souter master, a well-appointed stout ship of 400 tons burthen, in the employ of Mr. William Ward. The vessel carried about 90 men, and had 20 nine-pounders mounted on the main-deck, with nine whale-boats, some of them hung in the tackles over the sides, and others stowed and lashed on the deck.

We sailed from London in the latter end of March 1780, and, as is usual with Greenlandmen, called at the town of Larwick, the capital of the Shetland isles, where we found a most hospitable reception. A Mr. Innes, the most opulent inhabitant of that country, kept an open table for every master of a vessel and his surgeon; and no language can convey a proper idea of the kind and disinterested manner in which he received and entertained his guests. We lay there fourteen days wind bound. The country has a bleak barren appearance, the surface being generally rocky, or covered with turf, which is the fuel employed there; but the benevolence and hospitality of the more opulent, and the decency, sobriety, and good conduct of all the inhabitants, even those of the lowest class, more than compensate for the barrenness of the soil.

Provisions of every kind, the finer vegetables and fruit excepted, are very abundant here, and extremely reasonable. The price of a good fowl was threepence, of a dozen of new-laid eggs one penny; and as much excellent fish, cod, haddock, halibut, mackerel, &c. could be bought for one shilling, as would cost at least ten pounds at Billingsgate, or as used to dine our whole ship's company and the cabin. Potatoes, turnips, &c. are not more common there than peaches and apricots in England. Wheat flour is also a rare article, but the inhabitants in general prefer bread made of oatmeal.

The town of Larwick consists of about 200 houses, of one, or at most of two stories, which form a narrow crooked lane

on the sea side, badly paved with flat stones. All the houses are built of quarry stone: those of the rich are roomy, strong, convenient, and well furnished; those of the poor are small, and very smoky, for want of a proper arrangement of the chimneys.

Though the place lies in  $60^{\circ}$  north latitude, the winters are not severe; they are, however, wet and stormy. The harbour is very capacious and safe, and the anchoring ground good. About twenty or more English Greenlandmen were lying here at anchor, and several Dutch herring-busses. Having filled our empty water-casks, and laid in a stock of fowls, eggs, geneva, &c., we took leave of our kind friends on shore, and, the wind being southerly, hove up our anchor and set sail for the ice.

As we advanced to the northward the night became shorter till we came near North Cape in lat.  $71^{\circ} 10'$ , when we had no night at all. We were overtaken in that latitude by a most tremendous gale of wind from the north-east, which lasted three days and nights. Our ship lay more than once on her beam-ends, and every one on board thought she could never right again; but providentially we weathered the gale. A storm in those high latitudes is so intensely cold, when it blows from the north or north-east, that it is impossible to look in the wind's eye, as the cold is such as literally to tear the skin off the face.

In about  $76^{\circ}$  northern latitude we meet with ice floating in small round cakes, by the sailors called pancakes: you sail through this ice in perfectly smooth water; which, from being of a green colour in the North Sea, blue to the northward of Shetland and Ferro, grows gradually of a darker colour, and looks now of a deep black dye. We sailed several days through those floating ice-cakes. When in a still higher latitude, an open black-looking water re-appears; and when you reach about  $77^{\circ}$  or  $78^{\circ}$  you pass through large masses of floating ice 20 or 30 fathom thick, and some of them five or six times bigger than your own vessel. Great



care is taken to avoid striking against those masses, which sometimes are so close that there remains only a narrow channel for the ship to sail through. I have seen this continue for 24 hours or longer. When this is the case, the commander stands in the main or fore-top, and sometimes higher, and calls down to the men at the wheel how to steer. This navigation is attended with great danger, as the ice projects under water sometimes two or three fathoms.

After navigating through those floating masses, we saw the land of Spitzbergen east from us. It is seen at an almost incredible distance, sometimes at thirty leagues; a proof of its immense height. It generally appears amazingly bright, of the colour of the full moon; while the sky above it looks white and cold.

In  $79^{\circ}$  and  $80^{\circ}$  you are prevented from going further to the northward by a solid continent of ice, or a collection of ice-fields, as they are called; some of which are many miles in extent. You make the ship fast there with an ice anchor, and look out for whales, having two or three boats on the watch constantly.

No ship could ever possibly navigate through the huge masses of ice, which must necessarily be passed before it can reach this high latitude, but for a circumstance which would on first view be little expected—The sea there is always as perfectly smooth as the River Thames: the irregularly disposed masses of ice prevent the water from ever acquiring, by the impulse of the wind, those regular undulations, if I may use the term, which, by long continuance of the same impulse, would otherwise at last raise it in billows.

As soon as we got into smooth water, perhaps forty or fifty leagues from the land, the severe climate and intense cold we had experienced on the passage in a more southern latitude before we made the ice, changed into a much milder one; and when it was fine weather it was quite warm, so that the icicles that hung from the large masses of ice

ice dissolved and kept dropping till a return of colder weather. Among the fields of ice, but more so in the harbours, it is considerably warmer than on the passage near North Cape.

In the month of June we killed seven large whale fish, and went with them into Magdalena Bay, to cut the blubber up into small bits to fill the blubber-butts; which business is called *making off*. As the killing of the whales has been very well described by Zorgdrager and others, I need not describe it.

When you approach a harbour on the coast of Spitsbergen, and, judging by the eye, expect to get in and come to anchor in three or four hours time, you are perhaps not less than ten or twelve leagues from it. This deception is owing to the immense heights of the rocky mountains, covered with snow, and bordered with ice towards the sea-side, which make very large harbours appear like small basons, and the largest ships, when close under them, like a boat on the Thames. Magdalena Bay, in  $79^{\circ}$  north, is capacious enough to hold the whole British navy; but, on account of the immense mountains which surround it, appears like a very small inlet. We came to anchor in this bay, where we lay three weeks. While the people were making off, the masters, surgeons, &c. of the different vessels then there visited each other, and diverted themselves in the best way they were able. Such visits last sometimes 24 hours, for there is no night to interrupt the entertainment.

The first thing that strikes a curious mind here is that solemn silence which reigns around; sometimes interrupted with a noise, like thunder heard at a distance, occasioned by huge fragments of ice and rocks rolling down from the immense steep into the sea.

I attempted to ascend one of these mountains called Roche Hill. I got up about half way, which took several hours hard labour. At that height I found the rocks covered with birds eggs of different sizes.

There

There are several rivulets and waterfalls of excellent water supplied by the melting of the snow. I met frequently with scurvy-grass, wild celery, endive, water-creffes, and a few other plants and flowers; though the general vegetation which covers the rocks consists in various kinds of mosses and ferns. There are white bears of an enormous size, white foxes, deer, and elks; and above twenty different sorts of water and land birds; such as, wild geese, wild ducks, sea-parrots, roches, sea-gulls, malle-mooks as the sailors call them, whose quills make the best drawing pens I ever met with, wild pigeons, the white duck with a beautiful scarlet head and yellow legs, and the snow-bird, whose note is as pleasing as that of the bullfinch or nightingale.

This season was the finest ever remembered in those high latitudes, and we had almost constant fine weather. As we had room yet on board, and the season was not too far advanced, in hopes of killing a fish or two more, we left Magdalena Bay and steered north. When we arrived in  $80^{\circ}$  we found a perfectly clear ocean free from ice, but saw no whales.

We continued pushing to the northward with fine southerly breezes and most beautiful weather, and could, with a good telescope, discover no ice to the northward, from the main-top-mast head, but a solid continent of ice east and west; so that we were in a kind of channel of perhaps three or four leagues wide. We kept pushing on, the captain and I joking together about passing through the pole.

Both Captain Souter and myself found ourselves at length some minutes north of  $82^{\circ}$ , where perhaps no man before us had ever been, nor since. The high snowy mountains of North Bank, or North Foreland, appeared very luminous, and bore south on the compass.

We had a strong inclination to push still further north; but the danger of the east and west ice, now to the southward of us as well as to the northward, moving and locking us in, in which case we must have been beset and inevitably

lost, created a prudent fear, and induced the master to put about ship for North Foreland. The wind shifted at the same time to the northward, and in a couple of days we came to anchor on North Bank, called Smeerenburg's Harbour. We saw now plenty of fin-fish or finners, white whales, and unicorns; which is a sign that the season is over for killing the black whale, which then retires to the northward. As all these animals are well known and described, I forbear saying any thing respecting them.

One of our men having been at the habitation of the Russians in North Bank the year before, and assuring us that he could find the way to their hut, Captain Souter, a man of an inquisitive mind, proposed to me to pay them a visit. We took ten or twelve men with us, a compass, a few bottles of wine, bread, cheese, &c., and some good trade-knives, with a small keg of gunpowder, to make a present of to the Russians.

We landed at the bottom of the harbour to the eastward, where we found a large valley, several miles in breadth, surrounded with immense high mountains, mostly covered with snow; but as the sun had melted a part, the brown and black rock appeared, and rivulets of clear water ran down, forming little waterfalls.

The ground was turf and clay, and not bad to walk on: we had several small rivulets to cross, of two or three feet wide, but very shallow; near them we found scurvy-grass, water-creffes, endive, wild celery, and a few small flowers, and saw a number of land birds flying up at our approach. We crossed a piece of ground where the Dutch had formerly buried their dead: three or four of the coffins were open, with human skeletons lying in them. Some inscriptions on boards, of which above twenty were erected over the graves, had the years 1630, 1640, &c. affixed to them. We also saw the ruins of some brickwork, which had been a furnace, as the Dutch used to boil their oil here in the last century, and for that reason called it Smeerenburg's Haven, or

the Harbour of the Fat Borough. We had above six miles to walk to the northward, and were very much fatigued on account of the unevenness of the ground and the heat, when we discovered the hut of the Russians at a distance. They perceived our approach, and sent two or three people to meet and welcome us.

The common men made a strange appearance; they looked very much like some Jews in Rag Fair or Rosemary-Lane: they wore long beards, fur caps on their heads, brown sheep-skin jackets with the wool outside, boots, and long knives at their sides by way of hangers. When we arrived at the hut, we were presented to the caravelsk or commander, and to the surgeon, who both received us very politely, and invited us into the house, where we sat down to rest and refresh ourselves. Our people were introduced to their people in an outer room, and were entertained with meat and brandy. It happened fortunately that the surgeon was a German, a native of Berlin, of the name of Iderich Pochenthal, consequently I could converse with him; and we both acted as interpreters between his and our commander.

Captain Souter began with offering to the Russian commander, (who was also dressed in furs, only of a finer sort, and wore his beard and whiskers like the common men,) the keg of gunpowder and half a dozen of good table knives and forks: the Russian captain accepted them with a great deal of joy, and made us a present in return, consisting of half a dozen of white fox skins, two brown loaves of rye bread, six smoked rein-deer tongues, and two rib-pieces of smoked deer, for which we kindly thanked him. They turned out to be most excellent eating, and of a finer flavour than any English smoked tongues, or hung beef.

We placed our wine on the table, our bread and cheese, and the Russian captain ordered boiled smoked rein-deer tongues, new rye bread, and good brandy and water to be brought in. We all made a hearty, sociable meal; the tongues, and the rye bread, which was new and savory, were

a rarity to us; the Russian officers relished our Cheshire cheese and ship's biscuit as a very high treat. We drank the Empress of Russia's and King George's health. The Russian commander was an elderly man, of very agreeable manners; the surgeon extremely so, and very intelligent.

The hut consisted of two large rooms, each about 30 feet square, but so low that I touched the ceiling with my fur cap. In the middle of the front-room was a circular erection of brick-work, which served as an oven to bake their bread, and bake or boil their meat, and at the same time performed the office of a stove to warm the room. The fuel employed was wood, which drives on shore plentifully in whole trees stripped of their branches. A chimney carried the smoke out of the roof of the hut; but when they wished it, they could, by means of a flue, convey the smoke into the back room for the purpose of smoking and curing their reindeer flesh and tongues, bears hams, &c. Round three sides of the front room was raised an elevated place of about three feet wide, covered with white bear skins, which served for bedsteads. The captain's bed-clothes were made of white fox skins sewed together; the surgeon's was the same: the boatswain, cook, carpenter, and the men, had sheep-skins. The walls inside the room were very smooth and white-washed; and the ceiling was made of stout deal-boards, plained smooth, and white-washed.

The rooms had a sufficient number of small glass windows, of about two feet square, to afford light: the floor was hard clay, perfectly smooth: the whole hut was nearly 60 feet in length, and 34 wide outside; and was constructed of heavy beams cut square, of about twelve inches thick, laid horizontally one upon the other, joined at the four corners by a kind of dove-tailing, caulked with dry moss, and payed over with tar and pitch, so that not a breath of air can penetrate: the roof consisted of thin ribs laid across the beam-walls, and three-inch deal nailed over them, so that you could walk on the top of the house: the roof was caulked and tarred,

tarred, and perfectly tight. This is the manner of building houses in the country in Russia, particularly about Archangel.

The surgeon gave me the following account of this Russian colony in Smeerenburg's Harbour :

Some associated merchants at Archangel fit out a crabbla, or vessel, every year, of about 100 tons, with a commander, mate, surgeon, boatswain, carpenter, cook, and about fifteen hands, well provided with muskets, powder and shot, good large knives, and all kinds of utensils for killing whales, unicorns, rein-deer, bears, and foxes.

With a sufficient stock of rye-flour, brandy, clothing, snow shoes, deal boards, carpenters tools, &c. this vessel sails every year in the month of May from Archangel, goes round the North Cape of Norway, and arrives in June or July at Smeerenburg's Harbour, where the new colony is left on shore. The vessel stays two or three weeks in the harbour to refit, and carries the old colony with their cargo (consisting of whales' blubber, blades or so called whalebone, white bear skins, white fox skins, eiderdown and feathers, unicorns' trunks, which is an ivory that never turns yellow, and smoked rein-deers' tongues,) home to Archangel. The colonists have no wages, but receive thousandth shares for what they bring home : the captain has fifty shares, the mate and surgeon thirty each ; the carpenter, boatswain, and cook, ten each ; and each common man or boy has one share. The surgeon told me that the captain had above 1000 rubles due to him, and he himself about 600, and each common man perhaps 50 or 60 : that when they returned safe home, the common men would be able to live a whole year upon their money, and the officers much longer, as the necessaries of life were very cheap at Archangel ; and for the Company it had hitherto answered extremely well.

He told me this was his second trip, so well had it answered his expectations. " During the so called long nights," said he, " it seldom or never is so dark that you cannot see before you, nor is it so dreadfully cold as it is at Peterburg

every winter. When a snow storm happens, we cannot go out of the house; but when it is serene, and no wind, it is not too cold to go out and walk many miles. With the moonlight, the uncommon brilliancy of the stars in these high latitudes, and the reflection of the northern lights, or *aurora borealis*, we have so much light that we can see to read a book or to write.

“ In winter time the black whales come into the harbour and play close within shore, where we kill now and then one with harpoons fired out of a swivel. We kill white bears, foxes, rein-deer, and birds, as many as we can before the night-season, which commences in September, when all the land animals leave us and walk over the ice into Nova Zembla and Siberia: the land birds leave us in the same manner. Unicorns we also kill in the harbour, for the sake of their ivory trunks, which are afterwards sent to Germany and France.”

The surgeon and I had a race on snow shoes, which are a kind of skates, of about two feet in length, for skating over the snow and ice. As I was in former years a good skater, I could use them as well as he did. We ran six or seven miles with them in an hour without fatiguing ourselves: they have no irons.

Before we left our Russian host, he informed us, that a few weeks before they had, coming home from a shooting party, found an English captain and nine or ten men overhauling their property in the hut. The captain, finding that his chest had been broke open, and that his rubles were diminished considerably, reproached the English commander with the robbery, and a battle ensued. “ The English fired upon us,” said the surgeon, who acted all along as interpreter, “ and killed one of our men on the spot. We returned the fire and wounded some of his men, and caused them to retreat precipitately. When the English were gone, our captain counted his rubles, and found that there were 600 missing.” He intended to send a statement of the affair to the Russian government.

After



After having staid above twelve hours with the Russians, highly entertained, we invited them to come to see us on board and took our leave, returning the same way by the compass, and arrived safe on board, after having been absent almost eighteen hours.

We now prepared for the voyage home; and, after having filled our empty casks with good water from the shore, and made a clear ship, we set sail with a fine north-easterly breeze in the middle of July 1780. We sailed again through a great quantity of floating ice, and, our ship being a good sailer, passed several full ships bound homewards.

The first pleasing change we experienced was to have some night, and to be obliged to light a candle in the cabin. O what a luxury!—When you have no darkness for a considerable time (during May, June, and July), light becomes tedious at last; and the first time you see a candle burning in the cabin, and a dark night, the pleasure is indescribable. Before we came into this more southern latitude, I used to observe the setting of the sun, resting, as it were, on the horizon, appearing of a very large size, surrounded with most beautiful and glorious colours of various tints, and then the rising of it shortly after in full majesty. Language cannot convey an idea of the scene.

We came to anchor at Larwick towards the end of July, and were received in the kindest manner by Mr. Innes and all our friends in the place.

After three weeks stay we took leave of our Shetland friends, and sailed in company with a number of full ships for England. When we came on the coast of Northumberland and Yorkshire, the breeze and weather being favourable, we were delighted with the smell of the hay from the shore, and the sight of the pretty little towns and villages built on the sea-side, and refreshed with excellent fresh cod and haddock, which the Yorkshire cobs (a kind of fishing boats) bring on board; in return for which they prefer taking a piece of beef or pork to money: they bring some-

times eggs, potatoes, &c. We had an uncommonly pleasant voyage home, and constant fine weather, accompanied with northerly breezes.

We arrived about the latter end of August safe in Greenland Dock, after having been out five months.

Captain Souter kept an excellent table in the cabin, and a constant fire in the stove: his study was to make every person on board comfortable. In the fifteen voyages I have been to sea, I have only twice had the good fortune to sail with men of equal worth; Mr. Charles Patterson of the Sea Horse, and Mr. William Alder, now a Lieutenant in the British Navy.

VI. *An Attempt to arrange the Crystals of Oxidated Tin Ore, according to their supposed Structure.* By Mr. WILLIAM DAY, Leiceſter Place. Communicated by the Author.

THE crystallisations of oxidated tin ore are described by Romé de l'Isle, in his Cristallography, to be of the octaedral form and its modifications; the octaedra having isosceles triangular faces, inclined at an angle of  $45^{\circ}$  to the base of each pyramid; so that the junction of their bases and apices are right angles. In the following arrangement the octaedron is considered as the primitive form, and the modifications as being produced by an accumulation, on its faces, of laminae composed of similar minute molecu<sup>l</sup><sub>æ</sub>, experiencing different laws of decrement on their sides or angles, or on both. These laws of decrement are marked with the signs invented by Haüy, of which an account has been given in the Phil. Mag. Vol. II. p. 398. The greater part of these forms having been very accurately described by De l'Isle, all that is now attempted is an application of Haüy's system to the arrangement of this part of a private cabinet of English minerals; nor would it have been made public but for the repeated solicitations of several friends.

In

In the annexed drawing (see plate III.) all the plans, and also the figures marked *1 a*, *1 b*, and *1 c*, are geometrical: the others are drawings from models, and in perspective as they appear to the eye; but all of them placed in the same relative situation to the nucleus, fig. 1., on which they are supposed to be formed. Mathematical correctness is not attempted, nor is it necessary. The prisms are shewn with the pyramid on one end only; not on both, as in De l'Isle's plates.

Fig. 1, a perspective view of the primitive octaedron of oxidated tin ore. *1 a*, a front geometrical elevation, with the quantity of the angles marked upon them. *1 b*, an angular geometrical elevation, also with the quantity of the angles marked upon them. *1 c*, one of the faces of the octaedron, subdivided to shew the supposed arrangement of the primitive molecularæ that form one lamina. The dark triangles represent the spaces they occupy respectively, and the difference of shading, the progress of diminution by a subtraction of one range of molecularæ on the edges of the faces, according to the third law of decrement. The superior angle *A* of this face is  $70^\circ$ , the two inferior angles *E, E*,  $55^\circ$  each. The letters on the three geometrical figures mark the same situations on all of them, and are those employed by Haüy to indicate the laws of decrement.

As Haüy's *system* has been given in the First Volume of the Philosophical Magazine, and his *signs* in the Second, little more is required here but to give the sign to which the figures belong.

*First Law of Decrement*  $\begin{smallmatrix} \text{D} \\ \text{I} \end{smallmatrix}$ .

To this law belong fig. 2, 3, and 4. Fig. 2 *a*, without the dotted lines, would represent a plan of fig. 2. That portion of fig. 2 *a*, included between the dotted lines *b b*, *b b*, represents a plan of fig. 3. The plan of fig. 4 is evident from the figure.

*Second Law of Decrement*  $\begin{smallmatrix} \text{E} \\ \text{E} \end{smallmatrix}$ .

Fig. 5 belongs to this law: fig. 2 *a*, the angles being taken off at the dotted lines, represents a plan of it. Fig. 6 is a combination

combination of this law with another not yet determined, making the prism sixteen-sided: fig. 6 *a* is the plan.

*Third Law of Decrement*  $B \overset{I}{D} B$ .

Fig. 7 shews it incomplete. The plan is shewn, fig. 22 *a*, including the dotted lines. Fig. 8, the completion of this law: 8 *a* is the plan. Fig. 22 is an irregular formation, by this law taking place unequally: 22 *a*, (without the portion expressed by the dotted lines,) is the plan. The plans of two other unequal accumulations, which disguise the pyramid, are shewn fig. 7 *a*, 7 *b*. Fig. 21, the same as fig. 8, become euneiform: 21 *a*, the plan.

*Fourth Law of Decrement*  $A$ .

Fig. 9 shews the combination with the first law: fig. 10, the same with the third law, incomplete: fig. 11, the last completed: fig. 12, the combination with the first and second laws: this, and the combination with the first law only, are in general peculiar to Bohemian and Saxon ores; the English ores exhibit but few examples of them. I have an English crystal similar to fig. 9, and it is the only one I have seen. Fig. 13, the combination with the second and third law: fig. 13 *a* is the plan.

*Fifth Law of Decrement*  ${}^2E^2 \overset{I}{D}$ .

Fig. 14, the first indication of this law, in combination with the third law, incomplete. Fig. 15, this law farther extended in the same combination: 15 *a*, the plan. Fig. 16, a further extension, but still incomplete: fig. 16 *a*, the plan. Fig. 17, the completion of this decrement: fig. 17 *a*, the plan. Fig. 18, the combination of this law, when arrived at the stage shewn in fig. 16, with the third law. Compare fig. 15 and 18. Fig. 19 and 20 are the same as fig. 16, with some irregularity in the formation.

These five laws of decrement embrace all the varieties of facets I have yet observed (except those mentioned when speaking of fig. 6); and by combination, in different stages of

of each respectively, produce a great variety of forms, while other varieties arise from difference in colour and transparency to which all these crystallisations are subject.

The macles of De l'Isle, which Haüy has called *hemitrope*, or half-turned, may be added as a supplementary class. Of the term *macle*, De l'Isle gives this explanation: "When in any crystal whatever one or more re-entering or internal angles are observed, we may conclude that it is not a simple crystal, but a group of two or more; or even two turned or reversed moieties of the same crystal." De l'Isle was indebted to a Mr. Lermina for determining the direction of the section which produced the hemitrope crystals of tin, which he has shewn to be parallel to two opposite edges of the octaedron. Imagine the primitive octaedron to be divided into halves by a plane passing diagonally through it, from the centre B, fig. 24, of one of the edges of the superior pyramid, to the centre B of that edge of the inferior pyramid which is diagonally opposite; the plane will pass through two opposite angles FE of the base, dividing on each pyramid two adjoining faces into four scalene triangles, and leaving two adjoining faces perfect, but reversed on one pyramid in respect to the other. The plane FBEB' of this section is a rhomb of  $60^{\circ}$  and  $120^{\circ}$ .

The prismatic crystals appear to be as susceptible of that species of accumulation which produces the hemitrope as the octaedron, and the section is always parallel to the one determined above. If the prism is short, and terminated by two pyramids, the section will pass through the prism into both pyramids, and be irregularly octagon; but if the prism is long enough to permit the section to pass through it without encroaching on the pyramids, it will be a rhomb of  $70^{\circ}$  and  $110^{\circ}$ ; the same as the section of the primitive octaedron, perpendicular from the apex, and diagonally across the base.

I have some crystals which are produced by a double section, and both ends turned on the middle part; others which appear to be only portions taken off the angles at the junctions

tions of the pyramids to the prism, and reversed together without the intermediate part. In fact, the varieties appear to be almost innumerable.

After I had made the above arrangement, I received the 32d Number of the *Journal des Mines*, from which I beg leave to subjoin the following extracts:

“The primitive form of the crystals of oxydated tin appeared to me to be that of a cube performing the function of a parallelopipedon; so that the decrements which produce the secondary forms have, in regard to the two opposite faces of the cube, which must be considered as the bases, an action different from that which takes place in regard to the other four faces that represent the planes of the prism.” (p. 576.)

“One of the rarest varieties of this kind is that represented fig. 7 \*, and which is the seventh of Romé de Lisle, T. III. p. 422. We give it the name of *dijliquè* oxyd of tin; that is to say, with two ranges of facets. It has altogether thirty-six faces; four of which MM are vertical, and on each side eight inferior oblique  $\alpha, \alpha'$ , and eight superior oblique  $\sigma, \sigma'$ . If, as usual, we denote the edges of the base of the cubic nucleus by B, and the angles by A, we shall have, as the indicating sign of this variety,  $M (\overset{1}{A} B^2 B^3) \overset{1}{B} \overset{2}{A}$ , in which the intermediary decrement is referred to the facets  $\alpha, \alpha'$ , the decrement B to the facets  $\sigma, \sigma'$ , and the decrement  $\overset{1}{A}$  to the facets  $\sigma, \sigma'$ . The following is the indication of the principal angles: incidence of M to M  $90^\circ$ , of  $\alpha$  to  $\alpha$   $116^\circ 20'$ , of  $\alpha$  to  $\alpha'$   $158^\circ 30'$ , of  $\sigma$  to  $\sigma$   $120^\circ$ , of  $\sigma$  to  $\sigma'$   $150^\circ$ . Quantity of the angle  $n$   $118^\circ 4'$ .” (*Suite de l'Extrait du Traité de Minéralogie de C. Haüy*, p. 578.)

From the preceding extracts it appears that Haüy has supposed the cube to be the nucleus or primitive form of the oxydated tin crystals. I have again carefully examined the crystals in my own collection, and, according to the indi-

\* Fig. 23 is a tracing from Haüy's fig. 7, referred to here, and is the same crystal as represented fig. 18.

cations observed on them, from which I have formed my arrangement agreeably to the law laid down by Haüy himself, (see *Phil. Mag.* Vol. I. p. 292.) I see no reason at present why I should alter it. The crystals of oxidated tin are in general so hard and brittle that I have not been able to separate the laminæ; and there is nothing to guide the observer but the direction of the striæ on the secondary facets. Now the faces, which are parallel to the faces of the octaedron before mentioned, are always very brilliant; but those which are on a plane with the edges are striated parallel to those edges, particularly those crystals which shew the intermediate stages of the third law. If the nucleus were a cube, and the laminæ accumulated on it, to form the secondary crystals, shewed their direction by striæ on the new facets, those striæ would be in a direction quite contrary to what are shewn on these crystals: instead of going the length of the new facets parallel to the edges of the octaedron, they would cross the facets perpendicularly to their present direction, and it would be impossible for the crystal fig. 7 to take the form of fig. 8. In my collection there is a group of opaque black crystals, shewing all the variations from the primitive prismatic crystal fig. 2, to the completion of the third law of decrement fig. 8. In all of them the direction of the striæ is very evident. The Saxon and Bohemian ores of tin are most common in the cabinets of France: the crystals are larger, but do not present the varieties of forms that English ores do; being mostly confined to the octaedron and its hemitrope, and those variations of the fourth law which approach the cube. Had Haüy seen a greater number of the varieties of the English tin ores, I think he would, for the primitive form, have had recourse to the octaedron, which, by a very simple law of decrement, produces the cube and its varieties that occur in the tin crystallisations.

To these observations may be added De l'Isle's description of the same crystal that Haüy has described (above), which  
I find

I find to agree so well with what I have observed in nature, that I am inclined to suppose Haüy's measures of the angles are given from calculation, assuming the cube as the nucleus, and not from measurement on the crystal. De l'Isle's description is as follows :

“ It is a blackish kind of tin ore, in small solitary crystals five or six lines in length, and at most three in breadth. In the variety in question, one of the extremities of the rectangular tetraedral prism first presents an octaedral pyramid, the planes of which forming with the prism an angle of  $155^{\circ}$  are irregular pentagons, having one of their angles of  $60^{\circ}$ , two of  $120^{\circ}$ , one of  $110^{\circ}$ , and the most obtuse of  $130^{\circ}$ . These pentagons form with each other angles of  $110^{\circ}$  and  $160^{\circ}$ . The pyramidal form thence resulting is itself terminated by a tetraedral summit with trapezoidal planes joining at right angles, as is observed in the isosceles triangles of the third variety : but this summit becomes octaedral by the slight truncature of its edges, from which result four linear hexagons that form by their contact at the summit of the pyramid obtuse angles of  $110^{\circ}$ . The planes of the prism, had it not been broken, would be regular hexagons, and the whole crystal would then have thirty-six facets.” *De l'Isle's Crystallographic*, Tom. III. p. 423.

Having said so much respecting the external form, a few remarks concerning the chemical analysis of tin ores cannot be misplaced in a paper like the present. On this part of the subject, I cannot do better than by quoting from a paper of C. Guyton, formerly and better known here by the name of De Morveau, whose chemical authority always carries great weight with it. In his paper entitled, *Observations on the Acid of Tin, and an Analysis of its Ores*, after giving the analyses of the brown tin ore of Schlackenwald, as published by Mr. Klaproth, which he verified himself, and found to contain, tin 75, iron 0.5, flux 0.75, and oxygen  $23.75 = 100$ ; he proceeds to give a reason why the tin crystals



tals are so insoluble in acids, and combats the idea of Klaproth, that it arises from supersaturation by oxygen, which is dissipated by fluxing the ore with vegetable alkali.

“ I believed I had good reason,” says he, “ to doubt that the complete oxygenation, or (if the term be preferred) the supersaturation by oxygen, was the true cause of its insolubility in the muriatic acid; because I could not, at any one instant of the operation, perceive either the substance that should take it away, or any of the phenomena that would have accompanied its disengagement. That I might with the greater facility observe all the circumstances, I operated with a small platina crucible over an Argand’s lamp. Fifty-five centigrammes of brown crystals of tin were reduced to a fine powder, and mixed with six times as much pot-ash (purified by alcohol, and dried): the mixture was moistened with a few drops of water. I evaporated it first to dryness, and then to a commencement of fusion. After the first treatment, hot water poured on the mass dissolved more than half the mineral, which was then first precipitated from it by muriatic acid, and afterwards redissolved by it with the greatest facility; and the precipitate of the metallic oxyde, reproduced by adding carbonate of pot-ash, was found, as stated by Klaproth, completely soluble again by the same acid. After having myself witnessed this fact, my first doubt on the direct cause of the insolubility of this ore was rather strengthened than removed. It cannot be said that the excess of oxygen escaped during the fusion with the pot-ash; for the metal could not form a soluble combination with alkali, unless it was oxidated in the highest degree; or, more properly, in the state of an acid, so as that the solution filtered from the residue should be a true stannate, or (if the term be preferred) stannite of tin\*.

“ Now, if we are obliged to admit that *all the oxygen* of the ore is again found in the alkaline solution, it cannot be the loss of a *part* of that principle that renders the metal

\* The author must have written Stannite of pot-ash. D.

more soluble in the acid, for it is still found in the same state of saturation: besides, it does not exhibit any signs of the oxygenated muriatic acid gas; and in this case it is difficult to conceive why there should not rather be a disengagement of this gas at the time of digestion of the acid on the ore, as happens with the oxydes of manganese and lead.

“ To establish this point of theory on a decisive experiment, I dissolved six grammes of tin in nitrous acid, which I evaporated several times to dryness, adding each time fresh acid. I think it cannot be doubted that in this state the tin had taken all the oxygen it was capable of fixing; yet the mass of white oxyd, washed till the water that came from it did not in the least alter vegetable colours, was readily dissolved in muriatic acid. What then is the cause of the insolubility of the ore, which also is nothing but tin and oxygen, containing hardly 0.01 of extraneous matter? The cause can only be found in the state of aggregation of the latter. This assertion ought not to excite surprise, for hitherto sufficient account has not been taken of this power. If combinations are the result of affinity or elective attraction, this attraction itself is nothing but a power which may be rendered ineffectual by the sum of the forces which counteract it. These truths surely will not be denied by Mr. Klaproth, who has rendered them so palpable, by shewing us that the ruby, the sapphire, the adamantine spar, the elements of which were naturally easily soluble, resisted the ordinary means of analysis only by the state of the aggregation of their integral parts.”

De l'Isle, whose second edition was published in 1783, conjectured what Gayton here advances from experiment. His words are as follow:—“ I cannot agree with Mr. Bergman, that there is no mineralizing substance in the crystals of tin, because, in default of sulphur or arsenic, we ought at least to find *the acid principle*, by the aid of which the metallic earth of tin takes a constant and determinate crystalline form.”

VII. *Experiments respecting the Effects of Quicksilver on Vegetable Life.* By VON DEIMANN, PAATS VAN TROSTWYK and LAUWERENBURGH\*.

EXPER. I. A plant of the small garden bean, which had grown in the open fields, was placed in water close to a flask filled with quicksilver one inch in diameter, and the water was covered by a bell twelve inches in height and six in diameter.

II. A plant of curled mint, the root of which stood in water, was placed with quicksilver under a bell eight inches in height and four and a half in diameter.

III. The first experiment was repeated, with this variation; that the bell, instead of standing over water, was placed on a dish, and supported by pieces of cork.

IV. The same experiment as the second, with this difference; that pieces of leaf gold were suspended in the bell.

V. A flask filled with quicksilver was placed close to some young plants of the *spiræa salicifolia*, which still adhered to the parent root, and the whole was covered with a bell.

VI. The second experiment was repeated, and a little sulphur was applied to the interior sides of the bell.

VII. The second experiment again repeated, with this difference; that the quicksilver was covered with a little water.

VIII. A plant of the curled mint was placed in a basin of water with a little quicksilver, in such a manner that the roots were in contact with the metal.

IX. The roots of a bean plant, which had shot out through holes made in the pot in which it had been reared, were placed in a flat dish filled with quicksilver.

X. Some beans were planted in earth mixed with quicksilver.

XI. A plant of the curled mint was placed in a basin with water, and red oxyd of mercury prepared with the

\* From Scherer's *Allgemeines Journal der Chemie*, Vol. I. No. 6.

nitrous acid which had been washed first with an alkaline solution and then with pure water, the roots being immersed in the oxyd.

XII. The same as the second, with this variation; that instead of quicksilver the oxyd was used.

XIII. Beans were planted in a mixture of earth and the red oxyd of quicksilver.

XIV. The same planted in earth mixed with the oxyd of lead.

XV. Of three plants of the curled mint, one was placed, in the same manner as in the 11th experiment, in a phial which contained water and the oxyd of manganese; the second in another, containing water and the oxyd of copper; and the third in one containing water and the oxyd of lead.

The leaves and stems in the experiments 1, 2, 3, 4, and 5, were on the third day covered with black spots; and on the fourth, fifth, and at most the sixth, had become entirely black. The young tree in the 5th experiment could not hold out the whole summer, though it stood connected with the parent plant. The plants died so completely that the leaves frequently dropped off, and the stem sunk down the very moment the bell was removed. The plants in the 6th experiment remained without any change, which shews that sulphur prevents the bad effects of the quicksilver. In the 7th experiment the effect of the quicksilver was destroyed, on account of the water by which it was covered.

The experiments 8, 9, and 10, prove that the quicksilver, when mixed with earth or water, or when it stands in contact with the roots of plants, is in no manner prejudicial to them.

The 11th experiment, which we repeated several times, shewed us that the oxyd of quicksilver, placed in contact with the roots of a plant, is destructive to it. This oxyd, however, did not produce the same effect when it was placed as the metallic quicksilver, near to the plant; as was proved by the 12th experiment, in which the plant did not experience the least change.

In the 15th experiment the plants were not in the least affected by the different oxyds; which proves that plants, like animals, seem capable of being accustomed to things pernicious to them, provided they begin at infancy. The beans planted in earth mixed with the oxyd of quicksilver grew up, but so weak and stunted that they could scarcely be known. Those, however, which had been planted at the same time as the former in a mixture of earth and the oxyd of lead, shot up as usual, and exceeded them in strength and weight more than four times.

In these researches we were at great pains to make some comparative experiments, and we found that the plants in those where no quicksilver was employed, lived a considerable time in a state of perfect vegetation. These results we give merely as facts, without attempting at present to explain them. A considerable quantity of quicksilver placed in a very confined atmosphere may be equally pernicious to animal existence, as we think ourselves authorised to infer from several experiments, the course of which the late season of the year obliged us to suspend, and from which it appears that, in one point of view, things hurtful to animals are hurtful also to plants.

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VIII. *Observations on Animal Electricity; being the Substance of two Letters from A. VOLTA to Professor GRÉN.*

[Concluded from Page 68.]

THE very considerable difference in regard to the quantity of effect in the before-mentioned experiments already shews, that if the electric stream excited by contact is strongest towards a certain metal, when that metal is placed between a certain fluid on the one side, and another fluid on the other, there are other fluids which produce a greater effect with another kind of metal; so that it will be necessary to discover by experiment the particular arrangement of

conductors suited to each metal, in which the fluids or conductors of the second class must be disposed according to their activity. I have paid great attention to this circumstance, and have formed several tables, which I shall publish as soon as I have brought them to perfection.

I shall here, however, only observe, that in order to class, in some manner, the innumerable different moist conductors of this kind, I distinguish them into aqueous, spiritous, mucous, and gelatinous, saccharine, saponaceous, saline, acid, alkaline, and sulphurous (livers of sulphur) liquids; that I make subdivisions in the acids down to the best known simple mineral acids, (as I find in this respect great difference between the nitrous and the muriatic acids,) comprehending the principal vegetable acids and the acid of galls; and do the same in regard to the saline fluids, according as they are solutions of neutral salts, earthy salts, and particularly metallic salts.

When it can be determined in what order all these kinds of fluids follow each other, in regard to the power in question, for the metal A, and another for the metal B, &c., we shall then be in a condition to determine what place must be assigned to a great number of other heterogeneous fluids, whether mineral, vegetable, or animal, which belong to several of the above classes. In general, the order for the greater part of the metals hitherto observed is as follows: 1st, pure water; 2d, water mixed with clay or chalk, (which shews a pretty different effect when the before-mentioned experiment is made with two glasses, a bow of tin or zinc, and a properly prepared frog, which has a sufficient degree of vitality); 3d, a solution of sugar; 4th, alcohol; 5th, milk; 6th, mucilaginous fluids; 7th, animal gelatinous fluids; 8th, wine; 9th, vinegar, and other vegetable juices and acids; 10th, saliva; 11th, mucus of the nose; 12th, blood; 13th, brains; 14th, solution of salt; 15th, soap suds; 16th, chalk water; 17th, concentrated mineral acids; 18th, strong alkaline leys; 19th, alkaline fluids; 20th, livers of sulphur.

With

With some metals there is, however, a considerable deviation from this order, in regard to livers of sulphur, alkaline fluids, and the nitrous and saline acids.

As to the metals, which in their position between these different fluids are more or less proper for the electric effect in question, I have found in general that tin exceeds all others, and that silver is the worst; except when one of the fluids betwixt which the silver is placed is water, or any other aqueous conductor, and the other liver of sulphur: in this case silver far exceeds zinc, and even tin. Iron also produces a much greater effect than any other metal, when it is in contact, on the one side, with mere water or an aqueous conductor, and on the other with the nitrous acid, were it even only a drop. The excitement occasioned in both cases is wonderful; since it exceeds, as I have already remarked, that produced, according to the usual method, by means of a double metallic bow, even of different metals, as zinc and silver, applied to conductors of the second class of the same kind. It is sufficiently strong and powerful to produce convulsive movement in a half-prepared frog, the bowels of which have not been taken out, when one of the two moist conductors is a concentrated alkaline solution, and the metal placed between them is zinc, or rather tin. With other metals and other fluids you can seldom produce convulsions in a frog, if it be not perfectly prepared, or at least embowelled.

The reader will readily perceive, that when a bow of one and the same metal touches with both its ends the same kind of saline water, the same acid, the same alkaline fluid, &c. an electric stream will not take place, as happens also when it touches on each side merely water: in that case two opposite actions are opposed to each other, and keep each other in equilibrium. That these contrary powers, however, may be in perfect equilibrium, it is necessary that the fluids applied to both ends of the homogeneous metalline bow be exactly of the same kind and of the same strength. For this reason the

most careful attention and a certain dexterity are required in order to ensure success to the experiment, which I have often performed to the great astonishment of the spectators, and which any one may repeat as was done by my friend Humboldt. That philosopher has already published some of the most striking and decisive of these experiments in his second letter; and I shall here give a more particular account of them.

Having placed a completely or only half-prepared frog as usual in two glasses of water, take a very clean bow of silver (it will be best when it has been washed with water from the glasses), and immerse both ends of it at once, or the one after the other, in the glasses, no agitation of the frog will be occasioned. Repeat the experiment, after you have daubed over one end of the bow with the white of an egg, liquid glue, saliva, mucus, blood, a solution of tartar, or any other fluid or conducting substance sufficiently different from pure water. First, immerse the pure end, or that moistened merely with water, in the water of one of the glasses; and afterwards the other end, daubed over with the above substances, in the water of the other glass; you will then infallibly produce a convulsive movement in the frog, and several times in succession, if you draw out the bow and again immerse it until nothing more of the above substances is left adhering to the metal, or until the metal, with its ends in both the glasses, touches only pure, or nearly pure, water. Daub both the above substances uniformly over both ends of the bow, and immerse them at the same time in both the glasses of water, and no convulsions will arise. They will often be produced in newly prepared and highly irritable frogs, when the saline fluid, or, in general, the substance with which the two ends of the bow are daubed over, is not perfectly the same, or when the substance at the one end is more diluted than at the other, &c. Wash and clean carefully the one end of the bow, daub over the other more or less, and convulsions will be again produced as soon as the circle is made complete by  
the



the double immersion of the bow. Clean both ends completely, and no agitation will arise, as in the first experiment.

For comparative experiments of this kind I would recommend viscous fluids or substances rather than saline, because the latter are too soon dissolved in the water. It oftentimes happens that the convulsions of the frog, when it is completely prepared and highly irritable, take place, though both ends of the metallic bow are daubed over with the same kind of saline fluid. The cause of this is, that when one end is immersed in the water after the other, (and it may be easily seen that it is impossible to do so in a moment with sufficient accuracy,) the one end of the bow loses a portion of its saline substance sooner than the other, or at least the adhering part is more diluted by the water, so that the fluid with which both ends have been daubed over is no longer the same.

For these experiments I would also recommend silver, as a metal which is less liable than others to be attacked and changed by saline and other liquids. Tin, lead, copper, and in particular iron, are more susceptible of lasting variations; so that bows of these metals, and of iron above all, retain for a long time the power of producing convulsions in a newly prepared and highly irritable frog, even when both the ends of the bow are immersed in two glasses of water, although the places of the metal, attacked by any of the saline fluids, have been carefully washed and cleaned. A superficial alteration in the metal is sufficient to produce this change, as may be easily seen. These variations often shew themselves to the eye by a yellow blackish spot, &c. which it is difficult to remove. I do not here speak of lasting variations, that proceed to a greater depth, which can be produced in the end of the metallic bow, and particularly in iron, when its hardness is changed; a process by which such a bow can be rendered capable of producing not only convulsions in frogs, but also a particular sensation on the tongue, and light before the eyes, if both its ends, made perfectly clean, are only brought into contact with pure water. These, and many

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other

other experiments of the like kind, form the chief subject of my first letter to the Abbé Vassali, Professor of Natural Philosophy at Turin, written in the beginning of the year 1794, and afterwards published with the other in Brugnatelli's Journal.

If silver be less exposed to be attacked by saline and other fluids (except by liver of sulphur, which instantaneously renders it black); if it be less susceptible of considerable and lasting variations, and has therefore this advantage over other metals, that it is liable to fewer irregularities; tin, on account of its greater activity, that is, the strength of the effects which it produces by being brought into contact with almost all moist conductors, as I have already observed, is to be preferred to silver, and in a certain degree to all other metals. The experiment I have already described with a tin basin filled with an alkaline fluid, and held in the hands moistened with water, by which an acid sensation is excited on the tongue when brought into contact with the above fluid, is a proof of it; for it would be vain to expect a like effect from a basin of lead, iron, or copper, and much more so from one of silver. With the latter it would be obtained only when it contained liquid liver of sulphur; and in that case the acid taste would be pretty strong.

The electric fluid is excited also with the greatest strength and activity, when the metal is tin, between water and a saline fluid: but it will be excited with still greater energy to produce an acid sensation on the tongue when the tin is between water and an insipid mucilaginous fluid; or when the experiment is made with a tin basin filled with a solution of gum, liquid glue, white of an egg, &c. The other metals, in like circumstances, produce some effect, but much weaker: silver produces the weakest, except with liver of sulphur, as I have already observed.

A like experiment, which I made three years ago, and exhibited to various persons, not with two different fluids and one metal, as in that above described, but contrariwise,

with two metals of a different kind and a fluid, is already known. I took a basin of tin (one of zinc is better), placed it on a silver stand, and filled it with water. When any of the persons in company applied the tip of his tongue to the water, he found it perfectly tasteless as long as he did not touch the silver stand; but as soon as he laid hold of the stand, and grasped it in his hands well moistened, he experienced on the tongue a very perceptible and pretty strong acid taste. This experiment will succeed, though the effect is proportionably weaker, with a chain of several persons who hold each other's hands, after they have been moistened with water, while the first applies the tip of his tongue to the water in the basin, and the last lays hold with his hands of the silver stand.

If these experiments, in regard to the taste excited on the tongue by the action of two different metals, are striking, the others, in regard to the taste excited, modified and changed by one metal between two different fluids, are no less so, and they are also newer. They are still interesting on this account, that they discover to us the cause of that taste often perceived in water and other liquids, which is more or less considerable or various when drunk from vessels of metal, and particularly of tin. When the outer extremity of the vessel is applied to the under lip, rendered moist by the saliva, and the tongue is extended so as to be in contact with the water, beer, wine, &c. in the vessel, or when the tongue is bent as is done in drinking, is there not then a complete circle, and is not the metal between two more or less different liquids, that is, between the saliva of the under lip and the liquor in the cup or vessel? A stronger or weaker electric stream must thereby be occasioned according as the fluids are different—a stream which will not fail in its way to affect the sensible organs of the tongue in the said circle.

Besides the two methods already considered, of producing an electric current, that is, by means of one or more moist conductors, or conductors of the second class, placed between two different metals or conductors of the first class;

or

or contrariwise by means of a conductor of the first class placed between two of the second class, also different; there is still a third method of exciting the electric fluid, though in a degree so much weaker that it is scarcely capable of causing convulsions in a perfectly prepared frog; in which there is still a strong degree of vitality. This new method consists in forming the circle of three different conductors, all of the second class, without the intervention of one of the first or a metal one. Some think they find in this method a strong objection against my principle,

Fig. 20. represents this third method compared with the other two\*. In the experiments of Professor Valli, respecting which so much noise has been made without any reason, *z* represents the leg of the frog, and particularly the hard tendinous part of the *Musculus gastrocnemius*; *m* the rump or the muscles of the back, or the ischiatic nerves, to which the said tendinous parts are applied; and *a* the blood, or the viscid saponaceous or saline fluid, applied to the point of contact.

I have fully described this new method, where no metal is used, in my third and fourth letter to Professor Vassali, written in the autumn and winter of the year 1795. I have there shewn, that these new facts, far from altering my ideas and principles, serve rather to establish them; and that they render more general the principle that the conductors, by heterogeneous contact, that is of two different from each other, become exciters of electricity, and confirm the beautiful law arising from it, that to produce an electric stream the circle must necessarily be formed of three different conductors. You now see in what the whole secret, the whole magic consists; and that it depends not merely on metals, as might have been believed, but on all the different conductors. As long as we adhere to these principles, it will be easy to explain all the before-mentioned experiments without being reduced to the necessity of having recourse to any imaginary

\* See Plate I. (in the preceding Number.)

principle, or any peculiar and active electricity of the organs. By their assistance you will be enabled to invent new experiments, and to foretell the result of them, as I have several times done, and still do daily. If you, however, abandon these principles, you will find nothing but uncertainty and contradiction, and the whole will be an inexplicable problem,

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IX. *On the Method of manufacturing Acetat of Copper, Crystals of Venus, or Crystallised Verdigrise.* By J. A. CHAPTAL.\*

CRYSTALS of Venus were for a long time manufactured in Holland, but at present they are manufactured at Montpellier, with a degree of perfection which renders them preferable to those of any other country. The process most generally employed consists in dissolving verdigrise in vinegar, and evaporating the solution to a pellicle to obtain the crystals. The vinegar used is nothing else than four *vinasse* (spoilt wine) distilled. In every manufactory there is therefore an alembic, in which this weak kind of vinegar is continually distilled.

This distilled vinegar is put into a kettle, where it is boiled on the verdigrise. After saturation the solution is left to clarify, and then poured into another kettle of copper, where it is evaporated to a pellicle. Sticks are then immersed into it, and by means of some pack-thread are tied to wooden bars which rest on the edge of the kettle. These sticks are about a foot long, and are split cross-wise nearly two inches at the end, so that they open into four branches, kept at about the distance of an inch from each other by small pegs. The crystals adhere to these sticks, and cover them entirely, forming themselves into groups or clusters, which present on all sides perfect rhombs of a very lively dark blue colour.

\* From the *Annales de Chimie*, No. 75.

Each cluster weighs from five to six pounds. These crystals, when broken, exhibit on their fracture a brilliant agreeable green, inclining a little to blue.

Three pounds of moist verdigrise are necessary to make a pound of crystals. The undissolved residuum is rejected as useless. Analysis, however, having proved to me that a great deal of copper in a metallic state, or weakly oxydated, still exists in it, I disposed boards in the form of a stage around the manufactory of C. Durand, and, forming strata of about two inches in thickness with these remains, I soon saw them covered with an efflorescence of verdigrise. I took care to moisten them from time to time with vinegar, to dissolve the verdigrise as soon as a sufficiently strong efflorescence was formed, and they were again disposed in strata to proceed as before, in order that I might derive as much advantage from the residuum as I should find convenient.

There are some manufactories of the crystals of Venus where the verdigrise is prepared by means of vinegar distilled according to the method followed at Grenoble, which is well understood. All the operations tend to the same end, which is the solution of the copper in the acetous acid; and the purity of the materials renders it certain that there will be no residuum or loss. But however simple may be the process for manufacturing crystallised verdigrise, the high price at which it is sold makes it to be much wished that it could be still rendered more so. I made some experiments for that purpose; but at present I shall confine myself to a short view of my results. We must set out from the principle, that the acetous acid does not attack copper in the state of a metal, and that it cannot effect a solution of it but when reduced to an oxyd. The question then will be to discover the means of oxydating it in an economical manner.

1st, I exposed the plates of copper to the gaseous emanations of the oxygenated muriatic acid in large glass receivers, connected together in the manner of adoptors, to which I fitted a retort from which the acid was disengaged.

2d, I took

2d, I took a large earthen jar of Provence, well glazed, capable of containing two hundred (French) pints of water, buried it one half in a stratum of very warm dung in full decomposition, and having put some manganese in the bottom of it, and adapted to it a straight glass tube which reached from the mouth to the bottom, I filled the jar with plates of copper slightly rolled, in order that they might not touch each other but in some points. I then made to pass into the bottom of the jar, by means of the tube, the necessary quantity of the muriatic acid, and immediately closed the upper aperture with a luted covering. Two days after these plates were entirely crusted over with a greenish oxyd, which detached itself in dust and in scales: I separated of it two pounds ten ounces. This oxyd, less lively than that of the common verdigrise, is soluble in vinegar: and this method may then be employed, with some advantage, to form the acetat of copper; but it cannot supply the place of the acetous verdigrise either in painting or dyeing.

3d, I formed sulphat of copper by pouring, upon plates of copper brought to a red heat in a crucible, about a third in weight of pounded sulphur. This sulphure, exceedingly friable, pulverised and exposed to a pretty violent heat for four or five hours, left a grey powder, easily attacked by the acetous acid. That which I digested at a heat above a gentle temperature, gave, by evaporation, a considerable quantity of very blue and beautiful crystals of acetat of copper, and a stratum of true sulphat of copper of a pale blue and without crystals.

4th, I saturated distilled acetous acid with oxygenated muriatic acid gas. This acid, digested cold on the copper, dissolved it in part; but it formed a beautiful micaceous scaly white, which had no relation with the acetat. Copper exposed to the vapour of this acetous acid, saturated with oxygenated muriatic acid gas, becomes covered with very brilliant small crystals of a bright-blue colour, some of which are transparent and white. These crystals presented long  
square

square pyramids, effloresced in the air, and had none of the characters of the acetat of copper.

5th, The acetous acid, distilled several times on the oxyd of manganese, attacks copper and dissolves it, but too weakly and in too small quantity for me to recommend this method.

6th, The acetite of lead poured upon a solution of the sulphat of copper immediately produces a decomposition from which there results sulphat of lead, which precipitates itself in a little time; and acetat of copper, which remains in solution. By decanting the latter, and evaporating it to a pellicle in a copper kettle, you will obtain beautiful crystals of Venus. If you wash well the sulphat of lead, and prepare it to be employed in painting, as white lead, this last process may become very advantageous.

Crystallised verdigrise is in great request for painting and varnishing, to which it supplies lively and durable colours. Chemists obtain from it by distillation that acid, the smell of which is very penetrating, called *radical vinegar* and also *acetic acid*.

X. *An Attempt to determine the true Form and necessary Angles of Weather that ought to be given to Vanes of a Vertical Windmill as they recede from the Centre, left undetermined by Mr. Smeaton. By RICHARD HALL GOWER, in the Sea Service of the Honourable East India Company\*.*

ON reading Mr. Smeaton's Experiments to discover the proper Construction of Windmill Vanes, read before the Royal Society the 31st of May and the 14th of June 1759, I was sorry to find that millwrights had hitherto been without any fixed principle wherewith to give the vanes of vertical windmills their proper degree of weather.

If it were required to determine by calculation the number

\* Communicated by the Author.



of turns that would be made in a given time by a ventilator in a window, the fly of a smoke-jack, or the vanes of a vertical windmill, with a given velocity of wind, we must consider each vane as a spiral curve; for such a vane, when struck by a resisting fluid, must of necessity pass through a triangular space, of which the spread of the extremity of the vane forms the base, in the time that the wind passes through the depth of the vane: therefore, friction and gravity being out of the question, a fly of one vane will pass round as quick as a fly with any greater number.

Some years back I made a number of experiments upon spiral flies moving in water, to prove what number of turns the spiral would *actually* make in passing through a certain space in the direction of its axis; and I can with confidence assert, that (if the spiral be nicely made, and be such as shall be generated by a radius moving angular, and at the same time perpendicular to the plane of its angular motion\*) the revolutions it will make in passing through a certain space of water in the direction of its axis, *will admit of calculation*; but that, if the flies deviate from a spiral, the revolutions *are not to be calculated with exactness*, being ever *less* than the perfect spiral will perform. Wind is a fluid in some respects similar to water, particularly when applied to the present purpose; therefore, vanes which are to be turned by its power, *ought to be spirals, for, if not, they will ever perform less*.

For the purpose of elucidating, in the most clear and simple manner, the truth of the principle asserted, I caused a vane, or fly, to be made. This vane is represented by fig. 1, pl. IV. The vane moves round upon the pillar AB, which is fixed upright in a stand. The part of the pillar above the fly is square; this carries the brass arm CG, which may be moved up and down the pillar, parallel to itself, without revolving.

\* This construction might be otherwise expressed, thus: A spiral generated by the circular motion of a radius, and of a line moving at right angles, to the plane of the circular motion.

To this arm is fixed the straight wires 1, 2, 3, 4, 5, 6, 7, which are intended to represent the wind, moving parallel, to strike the vanes. To prove the truth of the principle, lift the arm up (as in fig. 1,) till the points of the wires are as high as the upper edge of the vanes, and bring the upper edge of either vane immediately under the points; then, by gently pressing the arm down, (as shewn by fig. 2,) it will be observed that the vane is turned by *all* the points pressing upon it *at the same time*, till they pass beyond its lower edge. Now, were the vanes any other than spirals, this could not be the case; for, bring the wires to the *plane vane* AH (fig. 3), (which may be set to any angle), and by pressing the arm down as before, it will be observed that, as the vane turns round, the points, beginning from the extremity, are quitted by the vane, which at length is acted upon by the point next the centre only: therefore it may be concluded, that the wind would not continue to act *uniformly* on any fly or vane which is not constructed on the principles of a spiral.

The spiral vane I, fig. 1, ends, as do the rest, where the angle of weather (or the angle which the vane makes with the plane of its circular motion) arrives at  $35^{\circ}$ , as this admits of the extremity of the vane being struck by the wind with an angle of  $54^{\circ}$ ; which angle, it is demonstrated, will produce the greatest lateral pressure. The shortening of the vanes of windmills is an object of material moment; yet I do not mean to assert that the angle of 35 degrees is the best concluding point, since, if more power be wanted, the length of the vanes must be extended. The wood, of which I formed my model, is preserved at the back of the vanes, (see the dotted lines fig. 1.) merely to give a better idea of their weather as they recede from the centre. Though the number of spiral vanes shewn are six, yet I do not say that six are superior to any other number; it being presumed that more vanes on this principle might be placed with advantage, provided the whole area of the circle be not too much crowded, which would prevent the free escape of the wind.

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The length, breadth, and angle of weather at the extremity of a vane being given; to determine the angles of weather at different distances from the centre.

Let AB, fig. 4, be the length of the vane; BC its breadth; and BCD the angle of weather at the extremity of the vane, equal to 20 degrees. With the length of the vane AB, and breadth BC, construct the isosceles triangle ABC: from the point B draw BD perpendicular to CB, then BD is the proper depth of the vane.

Divide the line AB into any number of parts (five, for instance); at those divisions draw the lines 1E, 2F, 3G, and 4H, parallel to the line BC; also, from the points of division 1, 2, 3, and 4, draw the lines 1I, 2K, 3L, and 4M, perpendicular to 1E, 2F, 3G, &c. all of them equal in length to BD. Join EI, FK, GL, and HM: then the angles 1EI, 2FK, 3GL, and 4HM, are the angles of weather at those divisions of the vane; and if the triangles be conceived to stand perpendicular with the plane of the paper, the angles I, K, L, M, and D, becoming the vertical angles, the hypotenuse of these triangles will give a perfect idea of the weathering of the vane as it recedes from the centre.

On the supposition that such a vane were infinitely extended, let us consider which part of it is most applicable to produce power with safety. The part of the vane next the centre, till it lessens the angle of weather to 80 or 70 degrees, sustains but little lateral pressure; and when the weather arrives at less than 20 or 10 degrees, it will sustain no more than at the centre, while, in the former case, the pressure tending to break the vanes is very considerable. If we consult a figure, constructed to shew the lateral and direct pressure that would arise from fluids striking surfaces with different degrees of obliquity, I think it may be concluded, *that the part of the vane between the weather of 80 and 20 degrees, will produce the greatest effect with the least danger.*

XI. *On the Assaying of Iron Ores and Iron Stones by Fusion.*  
*By Mr. DAVID MUSHET of the Clyde Iron Works. Com-*  
*municated by the Author.*

AMONGST the numerous and varied attainments of human genius, the results obtained in the practice of the art of fusion are not the least to stamp the industry of man with that full approbation to which the most ardent perseverance has entitled him. Destitute of the knowledge of principle, and labouring under the most violent prejudices, the artist has in all ages marked, at lengthened intervals, the coincidence of cause with effect: upon precedent alone he has ventured to enlarge his operations, and stake his fame and fortune. To this chiefly may be attributed his partial success; and by this alone can we account for the existence of manufactures, at an early period of civilisation, in this and in other countries. Although we cannot withhold our applause from such unremitting industry, yet the deep-rooted prejudices which this implicit reverence for custom has fostered are much to be regretted. In periods remote from our time, allowance will be readily granted for persevering in a mode of practice in which others had been comparatively successful; now, however, when investigation is abroad, the foundation of these principles ought to be tried by experiment, as the only standard whereby we are enabled to ascertain truth or detect error. At this impartial tribunal, errors may be detected which corrode the vitals of our manufactories; and truths which have hitherto slept, mingled in the rubbish of unenlightened tradition, be brought to full view.

In our manufactories, the just combination of art with science is what we can seldom boast; in authors the same happy union of theory and practice is also markedly deficient; and we have constantly to regret, that the want of liberality in the individuals of the one class, and opportunity in that of the other, prevent us from feeling the happy effects of this so much desired union.

The

The process of depriving ores of their metal by fusion in the assay-furnace, and that part particularly relating to iron, which I mean to make the principal subject of this paper, lead me more immediately to make these observations. With the manufacturer, in general, the uses and propriety of the assay-furnace are seldom admitted, or, at best, are restricted to such narrow limits as to be only capable of ascertaining the quantity of iron contained in ore or iron-stone. The chemist, on the other hand, intent only upon effecting his operation, and of giving accuracy to the result, confines his observations to a certain chain of science, and seldom or never considers manufactures as the ultimate and happy end towards which his labours should be directed.

With whatever deference and respect we look up to the names of men celebrated for their indefatigable zeal and industry in the cause of science, and with whatever satisfaction we rest upon the result of their labours as to truth; yet, in general, the practical man feels dissatisfied with the manner in which those subjects are treated which come more immediately under his own observation.

It is I fear with some truth that this charge is brought against that part of the arts relative to the assaying of iron ores. We never find, in the works of those whose attention has been directed to this subject, that the least connected idea ever exists betwixt the assay and the blast-furnace, or that the agents used for reduction in the laboratory can in general be applied to works in the large way. A total silence prevails amongst authors of this class, as to the various qualities of crude iron which certain ores and certain combinations of fluxes produce: all ores, however various, are reduced to the same complex treatment, and the operation itself measured by minutes, as if the fusibility of all the widely differently-combined ores was the same.

The celebrated Bergman even, has a degree of complexity in his receipts for the assaying of iron ores, that seems un-

worthy of the simple elements of science. The following one in particular seems to possess an air of incongruity even in the proportions, only equalled by the oddity of the assemblage of mixtures brought forward :

“ 100 Grains of the roasted ore, two parts of the black flux, (equal parts of borax and nitre,) one part of tartar, one of sal-ammoniac, one of sandever, half of (again) borax, half of glass, one-fourth of *clean foot*, one-fourth of charcoal ; the whole to be covered with common salt.”

This motley association of earths, alkalies, and salts, is recommended as the best flux for ALL iron ores. The author however shews, that the advantages which it possesses are not complete, from the great caution prescribed in the mode of conveying the necessary degree of heat ; and the perfection of the operation is rendered altogether doubtful by the consequences which the oversight of a *few minutes* may occasion.

It cannot be well reconciled to our ideas of advancement in any art, that we have not yet discovered a method of operation more perfect than that wherein a few minutes lost or gained (which error will more likely take place from the inequality of heat, than the reckoning of time,) make a variation from truth equal to 1-5th or 1-6th of the whole. The manufacturer would be in a lamentable predicament were he thus circumstanced, and obliged, by some means or other, to take the crude iron from the blast-furnace immediately upon being separated from the ores, lest a considerable portion of it should totally disappear. If the degree of heat produced from a smith's forge was at all times the same, though supplied with fuel of various natures, and under different changes of temperature, then it is most probable that, by reckoning Bergman's time to a minute, a button of iron, accurate in its results, might be obtained from *some* ores by the flux he has directed to be used. But I cannot conceive that this should be an universal consequence : far less can I comprehend, after a just separation has been effected, that

five minutes will destroy 1-10th of the produce of metal, while the incumbent fluid protects the surface of the metallic button from the action of the atmosphere.

It is not, however, my province to enter into a minute examination of the products obtained from the use of such vitreous fluxes, which are always productive of the most oxygenated state of crude iron; and the accuracy of whose results, under a state of such high oxygenation, are always to be suspected. I have frequently proved that, in using them, the affinity of the metal was so great to oxygen, that a slight derangement of the crucible, which had thrown the vitrid fluid from any point of the surface, was immediately attended by a rapid deflagration, and a considerable portion of the iron oxydated.

I shall chiefly confine myself to a communication of those facts, which I have repeatedly confirmed, with a view of extending my results and observations to a more extensive scale. I have constantly considered the assay-furnace as capable of affording conclusions applicable to the operations of the smelting-furnace, and that change or innovation should always have the concurring testimony of truth to back them, though, on a small scale, before they be risked on one more momentous or extensive. Influenced by such motives, I early rejected, as totally inapplicable to the scale of manufacture, the numerous tribe of salts, alkalies, and earths: these, in the application, are subject to no rule, nor guided by any immediate object of general utility, but are as arbitrary as their authors are numerous. On the contrary, I have directed my endeavours to the use of such agents as effect separation upon the large scale, and have been fortunate to find that the same solvents, when properly applied, are productive of the most perfect and finished results. By the simple application of lime or chalk, in various proportions, as a calcareous earth, and common bottle glass, in the place of flint, to constitute fusibility, I have been able to produce in the assay-furnace all the various qualities of crude

iron, as to strength and fusibility. In no case has the result of any assay been considered perfect, unless the vitrid mass found upon the surface of the metallic button exhibited a degree of transparency and purity of colour little inferior to flint glass, or slightly darkened by a faint shade of azure. In such vitrifications, purity of colour is the surest proof of the non-existence of iron in the state of a fused oxyd: the same degree of pellucidity renders it easy to detect the smallest globule of metal which by chance may have been suspended during fusion. In all experiments where a just association of mixtures has been present to produce this peculiar scoria, the quality of the iron will be found richly carbonated, and the button possessing a smooth, silvery, greasy-feel surface. On the other hand, experience has repeatedly shewn, that when the scoria obtained in assaying approached not to the colour and purity of fine glass, there remained a portion of the iron still unrevived, in the state of a fused oxyde, conveying colour and opacity to the mass; that at certain degrees of colour, certain degrees of opacity existed, and proportionate quantities of the metal remained diffused in the scoria. When the colour of this was green, the quantity of metal united was small; but as the green deepened, and became associated with light browns, the quantity of unrevived iron was greater, and became much increased as the scoria assumed darker browns, or became totally black: in such instances I have found it contain, upon being re-assayed, *12 per cent.* The assaying of iron ores is susceptible of another extreme, by which experiment is equally clogged, and wherein it is very difficult to obtain an accurate result. In this case no perfect button of metal is found, but the portion of iron which the ore contained is in a vast variety of various sized globules of the richest crude iron, interspersed in, or covering the surface of a semi-vitrified opaque mass of scoria, of a greyish-blue, mottled, or whitish colour. The causes of which, and their strict analogy to similar results in the blast-furnace, shall be my chief object to explain.



In a former paper I mentioned, that if iron-stones were smelted without the addition of any other substance, the product in iron would be proportioned to the quantity of lime contained in the respective classes. We shall see from the following experiments how far this is confirmed by means of the assay-furnace, and furnish to ourselves one important lesson, How far the various mixtures of ores affect the operation of smelting?

1st, Into a crucible, with a well-fitted cover, I introduced 875 grains of a pulverised siliceous iron-stone in its raw state, and applied such degree of heat as is usually given in such operations. In twelve minutes I found that the iron-stone was in perfect fusion, much agitated, and emitting large bubbles of ignited gas of a fiery colour. In forty minutes the crucible was withdrawn; the surface of the vitrid fluid still continued to boil, and emit bubbles, though in less quantity. In this state I introduced a small rod through the scoria, and discovered the surface of a button of metal. The moment it came into contact with atmospheric air, a beautiful combustion took place; the metal rose in a spiral form to supply the rapid inflammation, and continued till the scoria (still in fusion) closed over the surface of the button. When cold, I found a perfect formed button of extremely oxygenated crude iron, which weighed 219 grains; a produce equal to 25.1 *per cent.* from the raw iron-stone. The scoria obtained was of a shining black colour, firm and ponderous, and weighed 402 grains; so that the loss in volatile matter was 254 grains, equal to 29 *per cent.*

Although this iron-stone was siliceous, yet I am convinced the loss of volatile matter would have been greater, had not nearly one-half of the whole contents of iron remained in the scoria, united with oxygen, at the rate of 35 *per cent.* I found the produce of the metallic button thus obtained white as silver, and presenting imperfect radii; the surface was considerably oxydated, especially where the combustion had taken effect.

2d, I subjected to a similar treatment 875 grains of an argillaceous iron-stone, which contained a usual proportion of lime; the fusion of this powder was more difficult than that of the former, though the phenomena exhibited by both during reduction were alike. The crucible was withdrawn from the furnace in forty minutes after introduction, and the surface of the button exposed to combustion as before. The deflagration differed little in point of appearance from that effected with the siliceous iron-stone: the button of crude iron was found oxygenated, and weighed 249 grains; a produce in iron from the raw stone = 28.5 *per cent.*: the vitrid mass was found to weigh 354 grains; the loss of volatile mixtures was therefore 272 grains, or 31 *per cent.* The fracture of the regulus now obtained was still white, though not allied to any degree of crystallisation, and its surface smoother and less oxydated. The glass produced in this experiment was of a deep brown shining colour, in many places porous, and enriched with fine tints of colouring.

3d, The same experiment was repeated upon 875 grains of a fine calcareous iron-stone. The fusion of this required a violent heat of seventeen minutes, during which time the disengagement of a gaseous substance was most evident; in other respects it exhibited the same features, when in fusion, as the two former: the degree and length of heat conveyed was nearly the same; and the result obtained was a button of carbo-oxygenated crude iron \* weighing 261 grains; a  
produce

\* Although in this experiment a true carbonation is effected by means of the presence of lime alone, yet experience has never confirmed this in the large way; nor shewn, after a just proportion of materials was in the furnace, that additional lime alone conferred any additional degree of carbonation. The widely different manner in which the heat is excited, and the substances which are operated upon exposed to its action, may account for this want of coincidence of effect. It is the same principle that C. Clouet has lately ingeniously applied to the fabrication of cast steel from bar iron. To the decomposition of the carbonic acid alone, I attribute the advantages derived from the use of lime in the manufacturing of crude  
iron,

produce in iron equal to 30 *per cent.* from the raw iron-stone; fused earths, now reduced to an opaque brown glass streaked with white, 294 grains: loss in volatile mixtures 320 grains, or 36.5 *per cent.*

The metallic button produced in this operation had a smooth crystallised surface; and, when in fusion, combined less readily with oxygen offered by the contact of atmospheric air, than did the former two. The fracture was light grey, with a regular distinct grain; the mass of fused earths were disposed after the manner of a crystallisation, in radii, shooting from the circumference of a minute circle to the extremity of one larger.

From these experiments it is obvious that reguli of crude iron may be obtained from the different classes of iron-stones, of a respectable produce, without any addition whatever; and that the tendency which these have to part with their iron is in the exact ratio of the quantity of lime present. The following statement exhibits the difference betwixt the real and partial assay of the foregoing iron-stones.

The siliceous iron-stone, properly assayed, yielded 34.5 *per cent.*, but by fusion *per se* only 25; leaving in the latter method 9.5 mixed with the scoria. Argillaceous stone, properly assayed, gave 35.6, by fusion *per se* 28.5; leaving 7.1 mixed with the scoria. Calcareous iron-stone, properly assayed, yielded 33.7, by fusion *per se* 30; which left 3.7 mixed with the scoria.

One reason may be advanced why the iron produced from the calcareous stone was so much more in proportion than the other two classes: both the siliceous and argillaceous buttons, when deprived of their scoria, decomposed atmospheric air so rapidly as to suffer a little, in point of real metal, from the combination of oxygen. It was otherwise, however, when the surface of the calcareous button was exposed: the affinity of the oxygen to the metal being less

iron. I have for the last three years made use of this truth with the greatest advantage in the assaying of ores and other experiments.

than

than to the carbon united with it, carbonic acid was formed. A review of these experiments leads to another conclusion, that, without the presence of carbon, either in chemical union in the ore, or attracted from the ignited gas by the particles of metal, crude iron will not separate from the ore or stone; and that, in proportion as the metal is exposed to inhale this principle, its produce is increased and its quality improved.

It will further appear obvious, from the various natures of scoræ which the different iron-stones afford when fused *per se*, that there exists a want of mixture in most of them to form, when fused, a fluid so sufficiently divided that no portion of iron may be retained, either in a metallic state, or in that of an oxyde. This deficiency of mixture is greatest in the siliceous iron-stones, less in the argillaceous, and least of all in the calcareous. The principle, therefore, I proceeded upon was, to ascertain what proportion of additional mixture, and of what nature, was necessary to give the proper equilibrium to form a transparent scoria. When silex predominated, it was found that a major proportion of calcareous earth, in the solvent or flux, supplied the natural deficiency; and that the whole contents in iron were justly revived, and fully saturated with carbon: when at any time it was wished to revive the metal, contained in such ores, possessing strength with carbonation, I found that this could be easily effected, in all proportions, by the addition of calcareous earth with a mixture of pure clay. In short, in every experiment I have made with ores, the various natures of lime-stones, or chalk, with certain proportions of bottle glass, have been found capable of reviving the iron contained in all the ores which have come under my knowledge, and of conferring upon their respective products every degree of strength and fusibility\*. In order to form an accurate judgment of the tendency

\* Although I have frequently had occasion to mention the combination of clay with iron-stone, as the mixture which in fusion conveyed strength

dency which individual ores have to afford their metal carbonated, possessing strength, or otherwise, a flux of a medium proportion of calcareous earth and glass is determined upon; such as, with an iron-stone of that genus, would afford super-carbonated crude iron. Let the button of iron so obtained be the standard whereby to judge of succeeding results; and let all the ores belonging to the same mine, or used at the same work, be compared with it: these will be found, according to their mixtures, possessing different degrees of carbonation; some of them white in the fracture, and others again as richly carbonated as the standard regulus; their degrees of strength also approaching or receding from the standard as they approximate or vary from the nature and proportion of its original mixture.

To complete such an undertaking with accuracy, requires a minute knowledge of the operations of the assay-furnace, and the degree of heat from time to time excited: the quantity of ore in such a chain of experiments should be at all times the same, and the requisite heat conveyed and completed at similar stages of fusion and of separation. Strict

strength to the metal, yet I have not ventured a conjecture how far and in what manner the mechanical structure of the metal is altered when additional strength is thus obtained. It will be a difficult matter to decide, whether it is derived from the natural infusibility of the clay, by preventing separation for a longer time, and new modifying the structure of the particles of metal; or whether the acquired strength is entirely owing to the molecularæ of the metal becoming more flattened and tenacious by a varied stage of crystallisation. Most probably it is owing to both causes, and that the former is productive of the latter; the one the cause, and the other the effect accounted for.

We find, that from siliceous iron-stone, which is fused with the greatest facility, iron is obtained uncommonly white and brittle; and again, from pure calcareous iron-stones, which are still more difficult to reduce than the other two classes, we find an opposite extreme of brittleness, arising from an extra combination of carbon, which destroys the continuity of the particles to each other. Clay still holds the medium; and its addition alone restores a just equilibrium, not of strength only, but of fusibility.

accuracy of result, as to the quantity of metal, will not always be obtained; but a very comprehensive knowledge will be formed of the nature of the earthy mixtures, and the strength and fusibility of the metal. Once in the possession of these, it will be no difficult matter to superadd a portion of earths requisite for perfect reduction. In two simple experiments, therefore, not only the real quantity of metal contained in the ore is obtained, but its presumptive strength and fusibility developed in a great measure prior to its application to the purposes of the blast-furnace.

In order to facilitate this operation, and to compare the various degrees of heat in which different experiments are effected, I constructed a pyrometer upon the principle of the expansion of metal by heat; a representation of which, and a description of its use, will form an article for the next Number of the Philosophical Magazine.

XII. *Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE.

[Continued from page 71.]

CHAP. XVII.

*Observations to be made on the Remains and Vestiges of organized Bodies found in the Earth, in Mountains, and at their Surface.*

1. **T**HEIR nature, bulk, and quantity; the extent, depth, and other dimensions of the strata where they are found\*.
2. Their preservation. Whether entire or broken, decomposed or not; shells with their pearly covering (*nacre*); their colour; remains or traces of their fish, or their skin if there be any. To deduce, if possible, from these data, some idea

\* 1. A. If formed of trees, to mark down the direction of the strata; and whether they are placed horizontally, or inclined either towards the summit or the roots. C.

of the time that has elapsed since these organised beings were deposited in the bosom or at the surface of the earth.

3. The nature of the objects by which they are accompanied; such as sand, gravel, flints: whether angular or round; whether there are found in their neighbourhood other vestiges of organised bodies\*.

4. Their nature. Whether they are lying in their natural position, or reversed, and turned upside down, so as to afford reason to conclude that they died on the spots which they now occupy; or whether they have been transported thither by some violent and irregular movement: whether, for example, the shells have the same attitude as in the bosom of the sea, the univalves on their mouth, and the bivalves on the valve that is least convex.

5. Whether they are in families, as in stagnant waters; or, on the contrary, thrown together in an irregular manner.

6. Whether all these circumstances are the same throughout the whole extent of the same bank; in the contiguous banks of the same lands, and the same mountains, and in those of the neighbourhood.

7. To ascertain whether fossil shells are found in the most ancient mountains, and not in those of a more recent formation; and thus to class, if possible, the relative ages and epochs of the apparition of the different species.

8. To compare exactly the bones, shells, and fossil plants with the living plants analogous to them; and thus to ascertain the truth of the assertion of Michaelis, that the fossil bones of quadrupeds (such as the elephant, rhinoceros, oxen, and stags,) have not an exact resemblance to those which are found at present alive.

9. If they are really different, to determine whether these differences are not varieties, or whether they characterise species.

10. Whether, on the other hand, their identity is con-

\* To pay particular attention to those of such organised bodies as may be found in the real veins. C.

firmed with those of analogous living ones; viz. to ascertain whether these analogous living ones are found at present, or have been found within the memory of man, in those countries which contain remains of them; and if the answer is negative, to discover the situation and distance of the nearest country where they are found.

11. If no analogous ones exist alive at present but in climates where the temperature is very different, to ascertain whether there are any indications of their having formerly existed, and of their having been conveyed to those countries where remains of them are still found; or whether, on the contrary, these remains seem to have been transported thither by currents, tides, or any other great movement of the waters.

12. In the like manner, whether there are found in the cold countries vestiges of the productions of warm countries; or reciprocally, whether in warm countries there are found vestiges of the productions of cold countries.

13. Whether fossil wood, or other vestiges of organised bodies, are situated in such a manner as to indicate that there were in the ancient ocean islands abounding with animals and vegetables.

14. To study with care the immense accumulations of bones deposited in heaps (*nids*), or strata, in the isles of Cherso, Osero, and elsewhere.

15. To examine the nature of the caverns which contain them; such as *Baumannsbæle*, and others\*.

16. Whether it appears that these caverns were the voluntary retreats of those animals who died there a natural death, or whether their bodies were conveyed thither by the waters†.

[To be continued.]

\* In the Harz, and those of Gailenreuth in Franconia. C.

† Or, whether these bones are found, not only in caverns, but also in the strata from which the caverns have been formed. C.



XIII. *On the Cure of Persons bitten by Snakes in India* \*.  
By JOHN WILLIAMS, Esq.

THE following statement of facts relative to the cure of persons bitten by snakes, selected from a number of cases which have come within my own knowledge, require no prefatory introduction, as it points out the means of obtaining the greatest self-gratification the human mind is capable of experiencing, That of the preservation of the life of a fellow-creature, and snatching him from the jaws of death, by a method which every person is capable of availing himself of. Eau de Luce, I learn from many communications which I have received from different parts of the country, answers as well as the pure caustic alkali spirit; and though, from its having some essential oils in its composition, it may not be so powerful, yet, as it must be given with water, it only requires to increase the dose in proportion; and, so long as it retains its milky white colour, it is sufficiently efficacious.

From the effect of a ligature applied between the part bitten and the heart, it is evident that the poison diffuses itself over the body by the returning venous blood; destroying the irritability, and rendering the system paralytic. It is therefore probable that the volatile caustic alkali, in resisting the disease of the poison, does not act so much as a specific in destroying its quality, as by counteracting the effect on the system, by stimulating the fibres, and preserving that irritability which it tends to destroy.

CASE I. In the month of August 1780, a servant of mine was bitten in the heel, as he supposed, by a snake; and in a few minutes was in great agony, with convulsions about the throat and jaws, and continual grinding of the teeth. Having a wish to try the effects of volatile alkali in such cases, I gave him about forty drops of Eau de Luce in water, and applied some of it to the part bitten. The dose was re-

\* From the *Asiatic Researches*.

peated every eight or ten minutes, till a small phialful was expended: it was near two hours before it could be said he was out of danger. A numbness and pricking sensation was perceived extending itself up to the knee, where a ligature was applied so tight as to stop the returning venous blood, which seemingly checked the progress of the deleterious poison. The foot and leg, up to where the ligature was made, were stiff and painful for several days, and, which appeared very singular, were covered with a branny scale.

The above was the first case in which I tried the effects of the volatile alkali, and, apprehending that the essential oils in the composition of Eau de Luce, though made of the strong caustic volatile spirit, would considerably diminish its powers, I was induced, the next opportunity that offered, to try the effects of pure volatile caustic alkali spirit, and accordingly prepared some from quicklime and the sal ammoniac of this country.

II. In July 1782, a woman of the Brahmen cast, who lived in my neighbourhood at Chunar, was bitten by a Cobra de Capello between the thumb and fore-finger of her right hand. Prayers and superstitious incantations were practised by the Brahmens about her, till she became speechless and convulsed, with locked jaws, and a profuse discharge of saliva running from her mouth. On being informed of the accident, I immediately sent a servant with a bottle of the volatile caustic alkali spirit, of which he poured about a tea-spoonful, mixed with water, down her throat, and applied some of it to the part bitten. The dose was repeated a few minutes after, when she was evidently better, and in about half an hour was perfectly recovered.

This accident happened in a small hut, where I saw the snake, which was a middle-sized Cobra de Capello. The Brahmens would not allow it to be killed. In the above case, no other means whatever were used for the recovery of the patient than are here recited.

III. A woman-servant in the family of a gentleman at Benares,

Benares, was bitten in the foot by a Cobra de Capello. The gentleman immediately applied to me for some of the volatile caustic alkali, which I fortunately had by me. I gave her about sixty drops in water, and also applied some of it to the part bitten. In about seven or eight minutes after, she was perfectly recovered. In the above case I was not witness to the deleterious effect of the poison on the patient; but saw the snake after it was killed.

IV. In July 1784 the wife of a servant of mine was bitten by a Cobra de Capello on the outside of the little toe of her right foot. In a few minutes she became convulsed, particularly about the jaws and throat, with a continued gnashing of the teeth. She at first complained of a numbness extending from the wound upwards; but no ligature was applied to the limb. About sixty drops of the volatile caustic spirit were given to her in water, by forcing open her mouth, which was strongly convulsed: in about seven minutes the dose was repeated, when the convulsions left her; and in three more she became sensible, and spoke to those who attended her. A few drops of the spirit had also been applied to the wound. The snake was killed and brought to me, which proved to be a Cobra de Capello.

V. As it is generally believed that the venom of snakes is more malignant during hot dry weather than at any other season, the following case, which occurred in the month of July 1788, when the weather was extremely hot, no rain excepting a slight shower having fallen for many months, may not be unworthy of notice:—

A servant belonging to an officer at Juanpoor, was bitten by a snake on the leg, about two inches above the outer angle. As the accident happened in the evening, he could not see what species of snake it was. He immediately tied a ligature above the part bitten; but was in a few minutes in such exquisite torture from pain, which extended up his body and to his head, that he soon became dizzy and senseless. On being informed of the accident, I sent my servant

with a phial of the volatile caustic alkali, who found him, when he arrived, quite torpid, with the saliva running out of his mouth, and his jaws so fast locked as to render it necessary to use an instrument to open them and administer the medicine. About forty drops of the volatile caustic spirit were given to him in water, and applied to the wound; and the same dose repeated a few minutes after. In about half an hour he was perfectly recovered. On examining the part bitten, I could discover the marks of three fangs; two on one side, and one on the other; and, from the distance they were asunder, I should judge it a large snake. More than ten minutes did not appear to have elapsed from the time of his being bitten till the medicine was administered. The wounds healed immediately, and he was able to attend to his duty the next day. Though the species of snake was not ascertained, yet I judge, from the flow of saliva from the mouth, convulsive spasms of the jaws and throat, as well as from the marks of three fangs, that it must have been a Cobra de Capello; and though I have met with five and six fangs of different sizes in snakes of that species, I never observed the marks of more than two having been applied in biting in any other case which came within my knowledge.

VI. In September 1786 a servant belonging to Captain S—, who was then at Benares, was bitten in the leg by a large Cobra de Capello. He saw the snake coming towards him, with his neck spread out in a very tremendous manner, and endeavoured to avoid him; but, before he could get out of his way, the snake seized him by the leg, and secured his hold for some time, as if he had not been able to extricate his teeth. Application was immediately made to his master for a remedy, who sent to consult me; but, before I arrived, had given him a quantity of sweet oil, which he drank. So soon as I saw him, I directed the usual dose of volatile caustic alkali to be given, which fortunately brought away the oil from his stomach, or it is probable that

that the stimulating effect of the volatile spirit would have been so much blunted by it, as to have become inefficacious: a second dose was immediately administered, and some time after, a third. The man recovered in the course of a few hours. As oil is frequently administered as a remedy in the bite of snakes, I think it necessary to caution against the use of it with the volatile alkali, as it blunts the stimulating quality of the spirit, and renders it useless.

Of the numerous species of snakes which I have met with, not above six were provided with poisonous fangs; though I have examined many which have been considered by the natives as dangerous, without being able to discover any thing noxious in them.

The following is an instance of the deleterious effect of the bite of a snake, called by the natives Krait, a species of the Boa, which I have frequently met with in this part of the country:—

VII. On the 16th September 1788 a man was brought to me who had been bitten by a snake, with the marks of two fangs on two of his toes; he was said to have been bitten above an hour before I saw him: he was perfectly sensible, but complained of great pain in the parts bitten, with an unusual languor. I immediately gave him thirty drops of the volatile caustic alkali spirit in water, and applied some of it to the wounds. In a few minutes he became easier, and in about half an hour was carried away by his friends, with perfect confidence in his recovery, without having taken a second dose of the medicine, which indeed did not appear to have been necessary: but whether from the effect of the bite of the snake, or the motion of the dooly on which he was carried, I know not; but he became sick at the stomach, threw up the medicine, and died in about a quarter of an hour after. The man said that the snake came up to him while he was sitting on the ground; and that he put him away with his hand once, but that he turned about and bit him, as described. The snake was brought to me, which

I examined: it was about two feet and a half long, of a lightish-brown colour on the back, a white belly, and annulated from end to end with 208 abdominal and 46 tail scuta. I have met with several of them from thirteen inches to near three feet in length: it had two poisonous fangs in the upper jaw, which lay naked, with their points without the upper lip. It does not spread its neck, like the Cobra de Capello, when enraged; but is very active and quick in its motion.

I have seen instances of persons bitten by snakes, who have been so long without assistance that, when they have been brought to me, they have not been able to swallow, from convulsions of the throat and fauces, which is, I observe, a constant symptom of the bite of the Cobra de Capello: and indeed I have had many persons brought to me who had been dead some time; but never knew an instance of the volatile caustic alkali failing in its effect, where the patient has been able to swallow it.

XIV. *On the Metallic Particles contained in the Asbes of Vegetables.* By M. DE LA METHERIE\*.

FROM observations which have been made, there is no reason to doubt that Nature never produces any thing new on the one hand, without decomposing something old on the other. The process of boiling saltpetre, explained by the remarks of naturalists, has shewn that earth, freed from all salts by lixiviation, as soon as it is heaped up against new walls exposed to the open air, becomes again impregnated with different new salts: but these, however, have been formed by the experiments of Lavoisier, Thouvenel, and myself, through the effects of various artificial kinds of air. The greater part of salts are produced in the same manner in organised bodies; and thus plants produce vitriolated tartar, sulphur, nitre, both the fixed alkalies, and perhaps also

\* From the *Journal de Physique*, Vol. XXIII.

volatile alkali. The animal fluids give fever salts, (carbonat of ammonia,) sal-ammoniac, nitre, &c. Oils both sweet and essential, slimy bodies, and extracts belong exclusively to the works of animated Nature. Even the different kinds of gases combined with each other produce new kinds, as may be seen in plants, which convert foul air into oxygenated. Ought not the other substances found in organised bodies to be ascribed to the like works of Nature?

Becher and Henkel first shewed that all vegetables contain iron and gold, and since their time this fact has been placed beyond any doubt. Many chemists, particularly Lauragais, Rouelle, Darcet, Sage, Berthollet, &c. obtained both these metals from plants by reducing them to ashes \*. Are these substances contained in those things which furnish nourishment to plants, or are they produced by vegetation? This question can be applied also to the earth contained in plants. Duck-weed and all plants of this kind grow in the purest water, and we daily see bulbous plants shooting up in it.

Van Helmont relates, that he planted a shoot of woad, weighing fifty pounds, in a hundred pounds of earth. He watered it with distilled water, and in five years it weighed 169 pounds 3 ounces: the earth had lost of its weight only two ounces. Bonnet and Duhamel reared plants in the purest water, and they grew as well as in the best soil. It may be asked, then, if particles susceptible of being attracted by the magnet could have been found in the ashes of these plants, as well as in those of plants that grew in fields or gardens?

The author repeated many of these experiments. He calcined a part of various seeds, and extracted the ferruginous particles from them by means of a magnet; the other part he suffered to shoot, and to grow up in distilled water.

\* Since the time of their experiments manganese has been found diffused through plants, next in quantity to iron. See Scheele's Essays.

Their ashes gave a much greater quantity of metallic particles than the seeds; and produced also much more earth.

As Nature produces, in plants, salts, oil, and slime, may she not, in like manner, produce earth, iron, and gold in a metallic form? and, in this process, may she not employ water, light, and different kinds of gases, which it appears contribute most to the formation of salts and oils? In this manner metals would be brought very near to saline substances, which several chemists have already suspected.

XV. *Observations on Native Iron found in Strawberries\*.*

IT appears from the preceding article to be a circumstance well known to naturalists, that in the ashes of plants there are a great many particles susceptible of being attracted by the magnet, and which consequently must be of the nature of iron; but that this metal has been found in plants under its original metallic form, is a fact known only to a few. Grains of gold, however, according to the assertion of Becher, have at times been found in grapes, and threads of gold have been discovered in the roots of corn; tin and lead in the interior parts of plants; quicksilver in wood, &c.: but it has never perhaps been thought possible that iron should be found amidst the corroding juices of a plant, because no metal is so easily decomposed as iron, merely by the moisture of the atmosphere, acids, and the like.

A certain anonymous friend of natural history dined with several guests in the month of June 1781, at the house of his sister, situated on the road to Petershof, not far from Petersburg: after dinner some strawberries were placed on the table, in a plate, as part of the dessert along with other kinds of fruit. The anonymous person ate of the strawberries, as did all the other guests, without perceiving any thing

\* From the *Journal de Physique*, Nov. 1783.

remarkable;



remarkable; but one of the company at last called his attention to some hard black grains which he found in the berries he had eaten, and he soon observed that grains of the like kind were contained in those which he was eating himself. He did not imagine that these grains were iron, but he however wrapped them up in a bit of paper and carried them home with him, in order that he might examine them with more attention. He accordingly tried them by a magnet, and having observed that they were attracted by it, he entertained no doubt that they were real native iron. It deserves to be remarked, that the person to whom the anonymous naturalist was indebted for this discovery, and whose veracity is free from the least suspicion, asserted that he had often before found like particles of iron in the strawberries which he ate on the same farm. These particles were of various forms and sizes, but more or less flattened. Their black colour was very similar to that of ore found in dirty iron mines, only that it was much paler.

On closer examination, by means of a magnifying glass, these bodies appeared to be fragments broken off from larger pieces of iron, so that, with a little assistance from the imagination, traces of a regular fracture might be perceived on them. But even, whether we suppose that they were conveyed into the fruit as bodies before in a state of existence, or were gradually formed in the interior part of them, the explanation of the phenomenon will still be attended with difficulty. Their flattened form seems to oppose the idea of their having been produced in the fruit; but on the other hand, that of their being conveyed into the fruit with the juices through the stem, appears to be attended with much greater difficulty. The most singular circumstance is, that so many of these fruit in that district should have been furnished with these small bodies, and that they should have been found exactly in the centre.

Another instance of native iron being found, mentioned by the same anonymous author, is perhaps less striking, but

yet worthy of attention. In the neighbourhood of the town of Baturin in the Ukraine, there are a number of pleasant little hills intersected by various ravines formed by the waters. In these ravines there are found in different places white globular masses of calcareous stone, which on the outside bear marks as if they had been rubbed against black stones; these marks do not go deeper than the surface, and appear to be the work of some mineral pigment. The size of these masses approaches near to that of a walnut: it is however difficult to break them; and the nearer you get to the nucleus, which is distinguished from the external covering by a green yellowish colour, the finer and harder the grain is found. The middle of this stone consists of several cells separated from each other by partitions, some of which are exceedingly thin. These stone masses may be considered either as excrescences or petrefactions, and may be classed among the carpolites or alcyonites; but this is of little consequence.

What, however, deserves attention is, that, in one specimen which was broken, there were found in two of the cells two small grains which were immediately known to be iron by their being attracted by a magnet. The smaller fell from the hands of the observer, and was lost almost as soon as it had been discovered; but the other, which is still in his possession, has the exact shape of the cavity in which it lay, and is not much bigger than the head of a large pin. These discoveries afford a new proof that the existence of native iron is neither so uncommon nor so problematical as mankind in general believe.

XVI. *Seventh Communication\* from Dr. THORNTON, Physician to the General Dispensary, &c. &c. relative to Pneumatic Medicine.*

A REMARKABLE CASE OF PUTRID FEVER CURED BY  
THE INHALATION OF VITAL AIR.

AFTER attending a family labouring under putrid fever, I was seized myself with the same fever, but it was prevented forming by an emetic and calomel cathartic. It assailed next my wife, who being advanced in pregnancy, the same remedies could not be applied, and the fever actually formed itself. The symptoms became so alarming, that mustard cataplasms were applied to the feet; and there arising, towards the close of the disease, violent startings of the tendons, and a cold clammy sweat, with a fluttering and sunk pulse, I was induced to make trial of the oxygen air nearly in a pure state, and Mrs. Thornton was immediately revived by this remedy, and, after a fever which lasted one and twenty days, recovered. A servant in the house, and a nurse, were next seized; and I had the maid taken out of bed, and made her inhale thirty quarts of vital air, mixed with twice that quantity of atmospheric; which being repeated for a few days, she was completely restored. The nurse had an emetic, and went home. My two children were afterwards seized with the same fever; and being declared by the gentleman who attended them past all hopes, I ordered a carriage to be procured, and took them immediately to the top of Highgate Hill, where they were composed to sleep by the keen country air, and came home greatly revived; which excursion being repeated daily, they both recovered, to the surprise of every one. Seeing the good effects of air, and of facitious oxygen air, I adopted both in the fullest manner in the instance about to be recorded, the result of which the reader will see from the following

\* These are all *original Communications*, never having been before published. EDITOR.

letter from Mr. Corpe, an eminent surgeon and apothecary upwards of thirty years:—

*To Dr. Thornton.*

Barnet, June 11, 1799.

DEAR SIR,

My daughter was taken, the 27th of February 1798, with chills, followed by shiverings, considerable loss of strength, and depression of spirits. She continued suffering much from chills for about four or five hours, after which she complained of heat and flushing in her face, not attended with much thirst, and was a little delirious that night. The next day the symptoms increased, and the debility was so great that I was obliged, after the first passages had been thoroughly cleansed, to have recourse to wine and bottled porter, together with cordial antiseptic medicines; which plan was pursued, under your direction, during the progress of the disease; towards the close of which, the poor child was so shockingly debilitated, that we expected every minute would be her last, which induced you to direct vital air\*, by which, and the constant use of strong vinegar, thoroughly sprayed with a hearth-brush all over the room and curtains of the bed, revived her astonishingly: but the manner in which she constantly revived, after inhaling the vital air, must be chiefly attributed to it, as the vinegar had been used in the way before mentioned almost from the very beginning of the disease, and was, I believe, not only of great use to the patient, but prevented the fever spreading in my family. No poor human being, I believe, ever had a narrower escape from death; and I shall always feel myself under the highest obligations possible to you for your attention and extraordinary skill in restoring my dear child, with God's assistance, to,

Dear Sir,

Your much obliged and faithful Servant,

JOHN CORPE.

\* Sixteen quarts of vital air, mixed with the same quantity of atmospheric air, were administered in the evening.

P. S. I had almost forgot to observe, that the door and windows of my dear child's room were kept almost constantly open, and, being exactly opposite to each other, naturally created a free circulation of fresh air.

*Observations on this Case by Dr. Thornton.*

Miss Corpe, at: eighteen when I saw her, was convulsed; and the nurse said, "that, if it was her child, nothing more " should be given;" even her mother requested, "if there " really were no hopes, that she might not be disturbed by " medicine." What increased the alarm was: a tradesman a few doors off had lately died of this same fever under this eminent physician, leaving behind him a widow and six children. The case, indeed, seemed deplorable; but despair should never be allowed while there is life; and it authorised the exhibition of the vital air, which undoubtedly contributed much to the recovery of this amiable young lady.

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XVII. *On the Glazing of Earthen Vessels without Lead* \*.

AS it is well known that the common glazing by lead employed for earthen ware is of a pernicious nature and prejudicial to the health, H. Nieseman, a potter at Leipzig, has proposed the following:—Take nitre, pot-ash, and common salt, of each half a pound, with double that quantity of pulverised glass, and mix them well together; then take a well baked flat earthen dish, cover it pretty thick with well beat clay, strew over the clay as much sand as will adhere to it, and suffer it to dry. Put the above ingredients, well mixed, into this dish, and introduce it into the furnace in order that they may be all fused together. The dish, however, must be placed within another, in order that the ingredients may not be lost in case the dish should happen to crack: but if it be well covered with clay carefully bestrewed with sand, little danger is to be apprehended. When the ingredients have

\* From *Neue Sammlung oekonomischer Schriften*.

been fused, they are to be pounded very fine in the usual manner, and may be employed as the common glazing of lead. The colour of this glazing inclines a little to grey, but by the addition of the common calcareous spar it acquires a yellow colour: manganese gives it a brown colour; and the addition of copper ashes a green colour. To avoid, however, every thing that has the appearance of being pernicious, this mixture of copper ashes should be employed only for vessels which are to be used in washing. If this glazing is required for any particular purpose to be difficult of fusion, a little less litharge may be added to it; but the quantity in all cases must be so small as to leave no room for apprehending the least bad consequences. This substitute for the common glazing is strongly recommended by Professor Leonhardi.

XVIII. *Geographical Description of the Isles of France and Bourbon* \*.

THE Isle of France was discovered in the sixteenth century by the Portuguese, who called it the Isle of *Acerno*. The Dutch took possession of it in the year 1598, and gave it the name of the Mauritius, in honour of their Stadtholder Prince Maurice. It was not, however, till the year 1640 that they formed a settlement there, at a harbour in the south-east, which they abandoned in 1712, either on account of the little progress it made, or on account of their establishment at the Cape of Good Hope. In 1715 the French landed at the harbour in the north-west side, and named the island *Isle de France*. Soon after, in 1721, the inhabitants of the Isle of Bourbon, at present called *Isle de la Reunion*, which is situated at the distance of about ninety miles to the west of the Isle of France, formed a new settlement under the direction of Durongay. During fifteen years this colony was in a very languishing condition. It was

\* From Labarthe's *Annales Maritimes et Coloniales*.

rendered productive by La Bourdonnaie in 1735; and in 1764 the island was given up to the French government by the East India Company. After that period it was placed under the direction of a governor, and an intendant, or *ordonnateur*.

It lies in  $20^{\circ} 10'$  of south latitude and  $53^{\circ} 24'$  of east longitude from the meridian of Paris. According to La Caille it is 90,668 toises in circumference, 31,890 broad from east to west, and contains 432,680 square acres, each of 100 perches, and the perch of 20 feet. It has two harbours; one in the south-east, or the Great Haven, and the other in the north-west, called the Small Haven; also Port Louis, and, since the Revolution, *Port de la Montagne*. The most northern harbour is the principal port in the island. The north-west part of it is perfectly flat, but the south-east is covered with mountains; they are from 300 to 350 toises in height: the highest, at the mouth of the river Noire, is 424. The most remarkable mountain is called Pieterboth; it is 420 toises in height, and its summit ends in an obelisk, on which there is a large cubical mass of rock that no man has yet been able to ascend.

The island is watered by more than sixty streams, some of which, in the drougthy season, become totally dry, especially since the forests have been cut down. The interior abounds with lakes, and rain prevails during the greater part of the year, the clouds being attracted by the mountains and forests. The soil is covered with large or small stones; it withstands the plough, and must be cultivated with the hoe, yet it is very proper for various productions. Though of less depth and less fertility than that of the Island of Reunion, it is however, in general, more susceptible of cultivation.

The Island of Reunion (Bourbon) was discovered also by the Portuguese, who called it Mascarenhas, after the commander of the fleet; and this name was afterwards corrupted into *Mascaraigne*. In the year 1642 Pronis, the commandant at Madagascar, took possession of the island for

the French government. Seven years after, this was repeated by the new commandant Deffacourt, who gave the island the name of Bourbon. He introduced into it domestic animals, which multiplied considerably; and, on account of its fertility, several Frenchmen formed in it settlements. In the year 1665 two ships of De la Haie's squadron arrived here, and left Renaud, an *officer d'administration*, together with twenty labourers. The French who in 1671 escaped the massacre at Fort Dauphin, in Madagascar, fled to this island; and various sea-faring persons settled in it, and employed themselves in agriculture.

It is situated about ninety miles from the Isle of France, to the windward. One day only is sufficient for going from the Isle of France to the Isle of Bourbon, but a month is often necessary to return. It is about forty miles in length and thirty in breadth. The shores are exceedingly steep, and piroguas only can approach them without danger of being overfet. The soil is sandier than that of the Isle of France: at some distance from the shore it is mixed with those smooth stones (*galots*) which cover the bottom of the sea. The ground, however, in those parts which can be cultivated, is excellent. The mountains are exceedingly high: the three inaccessible peaks, called the *Salafis*, are said to be 1600 toises. There is here a very awful volcano, the district around which is entirely burnt up; and also a great many gulleys, the declivities of which are so steep that they cannot be cultivated. The chief port in the island is that of St. Denis; where a drawbridge, secured by iron chains, has been constructed for the purpose of enabling boats to land. This bridge extends more than eighty feet into the sea, and at the end of it is a ladder of ropes by which people who wish to go on shore must ascend: in all other parts of the island they must jump into the water.

About fifteen miles to the windward from St. Denis is St. Paul, where the sea is calmer, and the anchoring ground more secure: mariners, however, prefer St. Denis. This  
island



island produces annually 55,700 weight of corn, 54,300 of maize, and three millions of pounds of coffee. The most fruitful district of the island is that of St. Susanne, four leagues from St. Denis.

The sky is serene, the atmosphere pure, and the water salubrious. Land tortoises, which were here formerly so abundant, are found now only in the western part; in the other parts they have been exterminated by ships which have touched at the island. The wild goats and wild hogs have retired to the summits of the mountains: the rabbits, quails, partridges and pintadoes brought to the island have none of them increased, except the last. Le Gentil mentions as found here a bird called *Poisseau bleu*, a very delicate kind of bats; among the vegetable productions, ebony, benjamin, the cotton shrub; a great deal of timber for ship-building; and among the fruit-trees, the guava, the banana, and orange and lemon trees in great abundance.

## NEW PUBLICATIONS.

*Commentationes Societatis Regiæ Scientiarum Gottingensis, &c.* Transactions of the Royal Society of Gottingen, for the Years 1795—1798. Vol. XIII. quarto. Gottingen, 1799.

THE Physical Class of this volume, to which a preface by Professor Heyne is prefixed, contains the five following treatises:—M. Sömmering on an aperture in the centre of the retina of the human eye, observed in the body of a person who had been drowned.—M. Wrisberg on an unnatural conformation of the organs of generation in a boy.—Professor Gmelin's refutation of the grounds brought against the existence of phlogiston.—Dr. Lentin on the phosphoric acid as a cure for caries and rottenness of the bones.—M. Sömmering on the trunk of the lacteal ducts in the absorbing vessels lying on the aorta. The principal papers in the

Mathe-

Mathematical Clafs are :—Kaftner on the external furface of the fcrew.—Klugel on a new construction of a compound object-glafs.—Kaftner on the content of the threads of the fcrew and the fpace between. In the Historical and Philo-logical Clafs are :—A paper by Profeflor Heyne, to fhew that there was no extinction and revival of the arts in the middle ages.—Profeflor Heeren on the diverfity and affinity of languages in the ancient kingdom of Perfia.—Gatterer's fourth treatife on the Sarmatian extraction of the Livonians.—Profeflor Heeren on the ancient form of the Perfian gulph.—Profeflor Heyne on the means of difcovering the earlieft ftate of Homer's poems, and of reftoring them.

*Memorias da Academia Real das Sciencias de Lisboa, &c.*  
Vol. I. from 1780 to 1788. Lisbon, 1797. Small folio.  
575 pages.

THE Academy of Lisbon was indebted for its origin, in the year 1779, to the Duke de la Foes, uncle of the prefent queen, who is alfo prefident of it. The different branches of knowledge to which its attention is directed are : Natural Philofophy, Mathematics, and Domeftic Literature : and the Memoirs are divided into the fame number of claffes.

In the Physical Clafs are :—Domenico Vandelli *Floræ et Faunæ Lufitanicæ Specimen*, which is a mere nomenclature : *De Vulcano Olyffiponenfi et montis Erminii*, by the fame. The above two papers are in Latin, the reft in Portuguefe. Two papers by Joao Antonio Dalla Bella on the magnetic power. Various obfervations in chemiftry and natural hiftory, by Domingos Vandelli. Obfervations on a plant hygrometer, by Antonio Soarez Barbosa : this hygrometer is made of the twifted beard of the feed of a geranium. Physical obfervations in regard to the lightning which in different years had ftruck fome of the royal buildings at Mafra. Meteorological obfervations in various places by different men of learning. On the uncertainty of our knowledge refpecting the plant which produces myrrh, by Joao de Loureiro. On the nature and  
real

real origin of the *Agallochum*, from a plant entirely new, which the author calls *Aloexylum*, by the same.

In the Mathematical Class are:—A general solution of Kepler's problem *de demetriendo dolio non pleno*, by José Monteiro da Rocha. On the true principles of the doctrine of fluxions, by Borja Garçao Stockler. Additions to the rule of M. Fontaine for solving problems respecting the quadrature by approximation, by José Monteiro da Rocha. Various observations of the eclipses of Jupiter's satellites, made in 1775, in the royal college of Mafra, by D. Joaquim da Assumpção Veího. On determining the longitude and latitude of Lisbon, with the astronomical observations employed for that purpose, by Custodio Gomes de Villas-Boas. Observations of the same kind, and for the like purpose, made at Rio Janeiro, by Bento Sanches Dorta. Astronomical observations by Franc. Antonio Ciera and Franc. de Oliveira Barboza. Observations on the end of the eclipse of Dec. 17, 1781, made at Carthage, by D. Jacinto Ceruti. Solution of a problem, proposed by the Royal Academy of Sciences, respecting the approximation of M. Fontaine, by Manoel Joaquim Coelho da Maja.

In the Class of Portuguese Literature a series of papers is announced on the legislation and constitution of Portugal, by Antonio Caetano do Amaral. The first, which is here given, contains an account of the state of Portugal till it became a Roman province. This class contains also the two following articles:—On the Pastoral Poetry of the Lusitanians, by Joaquim de Foros; and a historical elogium of D'Alembert, by Franc. Borja Garçao Stockler.

*Philosophical Transactions of the Royal Society of London for the Year 1799. Part I.*

The contents are:—I. The Croonian lecture. Experiments and observations on the structure of nerves, by Everard Home, Esq. F. R. S.—II. The Bakerian lecture. Observations upon an unusual horizontal refraction of the air,

with remarks on the variations to which the lower parts of the atmosphere are sometimes subject; by the Rev. S. Vince, A. M. F. R. S. and Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge.—III. Abstract of a register of the barometer, thermometer, and rain at Lyndon, in Rutland, 1797; with some remarks on the recovery of injured trees: by Thomas Barker, Esq. Communicated by Mr. Timothy Lane, F. R. S.—IV. Some additions to a paper read in 1790, on the subject of a child with a double head: by Everard Home, Esq. F. R. S.—V. Observations on the manners, habits, and natural history of the Elephant: by John Corfe, Esq. Communicated by the Right Hon. Sir Joseph Banks, Bart. K. B. F. R. S.—VI. On the decomposition of the acid of borax, or sedative salt: by Lawrence de Crell, M. D. F. R. S. London and Edinburgh, and M. R. I. A. Translated from the German.—VI. A method of finding the latitude of a place by means of two altitudes of the sun, and the time elapsed betwixt the observations: by the Rev. W. Lax, A. M. Lowndes's Professor of Astronomy in the University of Cambridge.—VIII. A fourth catalogue of the comparative brightness of the stars: by William Herschel, L. L. D. F. R. S.—IX. On a sub-marine forest on the east coast of England: by Joseph Correa de Serra, L. L. D. F. R. S. and A. S.

The Appendix contains a Meteorological Journal, kept at the apartments of the Royal Society by order of the president and council.

## INTELLIGENCE,

AND

## MISCELLANEOUS ARTICLES.

## MIDWIFERY:

**I**N our Second Volume, p. 111, we announced a discovery said to have been made by Mr. Herholdt, an eminent accoucheur at Copenhagen, that the apparent death of new-born children arose from the trachea being filled with a liquid, and that they might often be restored by merely giving them a position favourable to its efflux. We then expressed a doubt as to the correctness of the observations; because it appeared impossible, from Dr. Goodwyn's experiments, that water could in any case enter into the trachea; and because, in those experiments in which it had been forced into the trachea, it had always been absorbed, if the animal was suffered to live. Candour, however, now calls upon us to state, that we find the following article in the *Journal de Physique* for Floreal, an. VII.

“An important discovery is announced in the *Medico-chirurgical Journal*, published by Professor Tode of Copenhagen \*. Herholdt has found, on opening the bodies of still-born animals, that the cavity of the tympanum was filled with the liquor of the amnios and with phlegm (viscous water). This fluid after birth issues by the auditory conduit, and is replaced by atmospheric air. This discovery induced him to suppose that the liquor of the amnios is introduced also into the canal of respiration before the child is born. *Experiments made at the veterinary school have confirmed this hypothesis.* Nature, in general, discharges this liquor, but sometimes it is necessary for that purpose to employ the assistance of art. A child cannot breathe easily

\* Vol. III. chap. 3. 1798.

until it is freed from it. Herholdt is of opinion, that this accident occasions more apparent deaths than is commonly believed. It is not sufficient then to rinse the child's throat; it must be placed in such an attitude as will facilitate the running off of the water. The author has had the good fortune this year to restore to life twelve children out of thirteen who were in the like situation. Professors Abildgaard and Wi-borg have confirmed this experiment by opening five puppies cut from the belly of the mother."

#### NATURAL HISTORY.

The following incident has lately attracted much notice at Paris:—Citoyen Felix two years ago brought two lions, a male and female, to the national menagerie. About the beginning of June Felix fell ill, and could no longer attend the lions; another was forced to do his duty. The lion, sad and solitary, remained from that moment constantly seated at the end of his cage, and refused to receive any thing from the stranger. His presence even was hateful to him, and he menaced him by bellowing. The company of the female seemed also to displease him; he paid no attention to her. The uneasiness of the animal afforded a belief that he was really ill, but no one dared to approach him. At length Felix got well, and meaning to surprise the lion, he crawled softly to the cage, and shewed only his face against the bars; the lion in a moment made a bound, leaped against the bars, patted him with his paws, licked his hands and face, and trembled with pleasure. The female ran to him also; the lion drove her back, seemed angry, and fearful that she should snatch any favours from Felix; a quarrel seemed about to take place between them, but Felix entered the cage to pacify them. He caressed them by turns. Felix is now seen frequently in the midst of this formidable couple, whose power he has fettered: he holds a kind of conversation with them. Does he wish that they should separate and retire each to their cages, he has only to speak a word; does he wish that they should lie down to shew strangers their paws armed with  
terrible

terrible claws, and their throats full of tremendous teeth—at the least sign from him they lie on their backs, hold up their paws one after another, open their throats, and, as a recompence, obtain the favour of licking his hand.—These two animals, of a strong breed, are five years and a half old; they were both of the same mother, and have always lived together.

#### FULMINATING OXYD OF MERCURY.

It is well known that C. Bayen, Brugnatelli, and others, some time ago discovered that nitrats in general, those of the metals not excepted, detonate with combustible substances, especially with sulphur. That some preparations of gold and of silver possess the property of fulminating without the addition of any inflammable substance, has also been known for some time. We have now to announce, that a method of preparing an oxyd of mercury, different from any described by Bayen or others, that may be fired like gunpowder, and detonates loudly with a gentle stroke of a hammer, has just been discovered by Mr. Edward Howard. We have not yet received a correct account of the process for preparing it, but, from the wonderful expansive force it exerts on being fired, we have not a doubt that it will prove a very useful discovery. A few grains of it tried in a gunpowder proof, instead of merely raising the flap to some point within the range of the attached scale, fairly shot it off; and the piece detached, on being examined, was found to have received such a blow from the newly-generated gas as to be absolutely dented by it, as if it had received the impression of a punch by means of a heavy hammer: the cavity was exactly the diameter of the bore of the proof, and, what is extremely singular, of an equal depth all over. A charge of only thirty-two grains laid open, for two inches in length, the breech-end of a very strong musket barrel on the two opposite sides, the force being too great to allow time to the gas to wiredraw itself (if we may

use the term) to enable it to pass off through the calibre, —In a future Number we shall lay farther particulars before our readers respecting this discovery.

#### EFFECT OF HYDROGEN GAS ON THE VOICE.

The *Journal Britannique*, published at Geneva by Prevot, contains the following article :—" Maunoir was one day amusing himself with Paul at Geneva, in breathing pure hydrogen air. He inspired it with ease; and did not perceive that it had any sensible effect on him, either in entering his lungs, or passing out. But after he had taken in a very large dose, he was desirous of speaking, and was astonishingly surprised at the sound of his voice, which was become soft, shrill, and even squeaking, so as to alarm him. Paul made the same experiment on himself, and the same effect was produced. I do not know whether any thing similar has occurred in breathing any of the other gases."

#### CHEAP METHOD OF PREVENTING THE DISAGREEABLE SMELL OF PRIVIES.

In some houses, privies, when badly placed and ill taken care of, diffuse an odour as inconvenient as unhealthful; but the means of remedying this evil is exceedingly easy. If a certain quantity of milk of lime (water in which lime has been dissolved, and whitened by the fine particles of that substance) be mixed with a ley of ashes, or soapy water that has been even used for washing, be thrown into the sink of the privy, it will destroy the offensive smell. By these means, for the value of a few pence, any collection of filth whatever may be neutralised. By the same process conveniences for sick persons may be kept in their apartments. Nothing is necessary but to have a tub covered with a board as a seat; five or six pounds of quicklime, a small quantity of ashes, and two buckets of water thrown into the tub, will prevent any disagreeable odour. It may readily be conceived that the same process may be employed in regard to a night-chair.



chair. The fecal matter, after being thus neutralised, is an excellent manure for land.

#### LENGTH OF THE METRE.

From the *Journal de Physique* we learn, that the report which has been made of the length of the metre at Paris by the learned men employed in determining the length of a degree of the meridian, has been fixed at 3 feet 11 lines and 1,296 of a line. On this basis all the other measures are to be formed. We shall give hereafter a more particular account of this operation, which leads to some changes in the results before given by approximation.

#### TRANSIT OF MERCURY.

“ I waited with impatience for the passage of Mercury over the sun’s disk in his descending node. It had never been completely observed in that position, and there will not be another for thirty-three years. I had the pleasure of observing Mercury enter the sun’s disk, like a small round black spot, on the 18th of Floreal (May 7th) in the morning, at the very moment pointed out in my new tables. The principles on which they are founded I have explained in the first memoir read at the first meeting of the first class of the Institute immediately after its establishment. This is the more satisfactory, as, in the calculations for the transit of the 4th May 1780, there were forty minutes variation from the best tables of Mercury. LALANDE.”

#### PREPARATION OF BRUNSWICK GREEN.

Kastleyn has lately published the following method of preparing this colour, which is much used on the Continent for oil painting, and in the manufacturing of printed paper. Shavings of copper are put into a close vessel, and besprinkled with a solution of the muriatic acid. The metal first unites with the muriatic acid, and is dissolved, and is in its turn precipitated by the disengaged ammonia, to which it now joins itself. The precipitate is then washed

and dried in wooden boxes, or upon an extended cloth. The liquid which remains, as well as the water of the first washing, may be employed several times in succession for new operations, by dissolving in it fresh portions of sal ammoniac to the point of saturation. Three parts of the muriat of ammonia are sufficient for two parts of copper, and the result is six parts of colour. This beautiful green is in Holland called Friesland green. It is almost always adulterated with ceruse.

#### CEMENT FOR FILLING UP CRACKS AND FISSURES IN IRON VESSELS.

The same author has also made known this cement. It consists of six parts of yellow potter's clay, one part of the filings of iron, and a quantity of linseed oil sufficient to form the whole into a paste of the consistence of putty.

#### GREN'S EUDIOMETER.

Professor Gren, in a work of his lately published\*, proposes the following method of constructing an eudiometer by means of phosphorus; which, though slow in its operation, will give a very accurate result. Take a small cylindrical glass tube, sealed at the one end, and divided from that end by means of a scale into sufficiently small equal parts; fill it with distilled water, plunge it into a basin of the same liquid, make to ascend a quantity of the air to be examined, and note the state of the atmosphere at the time, as indicated by the barometer and thermometer. Through a cork, smaller in diameter than the tube, stick a few needles, and place on the upper end of them a bit of pure clear phosphorus: fasten a thread to the bottom of the cork. Introduce this cork into the lower end of the tube, with the phosphorus uppermost, in which it will rise to the surface of the water; so that the phosphorus on the needles will come in contact with

\* Grundriß der Naturlehre. Halle, 1797.

the gas in the upper end of the tube. The tube must now be left inverted in the vessel filled with water, in which it must remain. The phosphorus will undergo a slow and gradual combustion: by means of the thread the cork from time to time may be drawn under the water to wash off the acid produced by the combustion, and, adhering to the phosphorus, to hasten the process. When all the oxygen gas is consumed, and the remaining phosphorus is no longer observed to shine in the dark, the cork must be drawn out; and the observer must note, at a corresponding height of the barometer and degree of heat with that of the atmosphere when the process commenced, the quantity of azot remaining, and how much oxygen has been consumed.

#### METHOD OF PROVING WHETHER COTTON BE ADULTERATED WITH WOOL, or *vice versa*.

You may easily ascertain whether cotton is mixed with wool, by subjecting it to the action of the oxygenated muriatic acid, which will render it white, at the same time that it makes the wool yellow. Professor Brugman, of Leyden, has by the same means been able to determine with certainty what part in the brain is the medullary substance, and what part the nerves; and to discover the latter even at their origin, where most concealed.

#### OXYGENATION OF SNOW AND RAIN,

In our last volume, page 233, we gave a paper by M. Hassenfratz on the oxygenation of snow and rain, and their effects on vegetation. In that paper M. Hassenfratz divides the action of snow into parts. 1st, As preserving plants from the great cold of the atmosphere; 2d, as causing a greater number of seeds to expand by means of the oxygen with which it supplies them. M. Hassenfratz proved the presence of oxygen in snow by its rendering turnsol paper red, and precipitating oxyd of iron from a solution of the sulphat of that metal. Dr. Joachim Carradori  
de

de Prato has, however, lately asserted \*, in opposition to M. Hassenfratz, that snow is not oxygenated: 1st, because fish which lived very well in common water, did not live in recent snow water, but died in a short time: 2d, because snow water exposed to the action of light did not suffer oxygen gas to be disengaged. He ascribes therefore the sudden death of fish, and the non-production of oxygen by light, to the want of that substance in snow water. M. Hassenfratz has observed, in answer to these objections, that animals may die either through the want or by an excess of oxygen, as well as by the want or an excess of nourishment, and that a mean proportion of both are necessary for the preservation of life and health: that all oxygenated substances do not disengage their oxygen on being exposed to the light; and that when it is disengaged, they suffer only the excess to escape—another portion remains which cannot be taken from them by that agent. Dr. Carradori," says M. Hassenfratz, "does not deny the results of the experiments I have announced; he only thinks they are not conclusive, because fish do not live in recent snow water." He therefore promises, as soon as he can procure snow water, to repeat Dr. Carradori's experiments; to vary them, and make new ones, in order to prove in the most positive manner the existence of oxygen in snow, and to determine the causes of the phenomena which seem to belong to it exclusively.

#### EUROPEAN SUGAR.

We are informed by Professor Beckmann, that the Chamber of the Mark at Berlin has lately been at great pains to promote the manufacturing of sugar from plants indigenous in Germany. Some experiments were made for that purpose with the juice of the maple, which was refined in a sugar bakehouse, and found to be equal to loaf sugar. Professor Beckmann, who saw specimens of it, says, it has been found

\* See his experiments in the *Journal de Physique*, Ventose, an. 7. p. 226.

that the Virginian red maple, or silver-leaved maple (*acer rubrum*), gives more sugar than the sugar-maple (*acer saccharinum*); which is the more fortunate, as the latter withstands better the cold of an European winter. The Professor adds, that attempts are making in Brandenburg to cultivate this tree, and that seeds have been ordered from America, but they have not yet arrived.

#### ERUPTION OF THE PEAK OF TENERIFF.

Fleurieu lately announced to the National Institute, that a sea-captain had actually seen the Peak of Teneriff throwing up fire. According to La Cede, no eruption from the Peak has taken place for 400 years. Fleurieu himself had often seen smoke arise from it, and found the earth near the crater somewhat warm.

#### TORNADO.

The following account of a phenomenon of this kind, which took place at Whitelaw, in the parish of Ednam, Berwickshire, on the 3d instant, is copied from the Kello Mail:—

“ The weather through the day had been calm, with soft showers. At seven o'clock in the evening there was observed by many people, a little to the south-west of Mr. Tod's house at Whitelaw, a dense light-coloured cloud of a very uncommon appearance. It resembled an inverted cone, reaching from the ground to a considerable height in the atmosphere. Its motion towards the house was slow and majestic; a person of no great agility, on seeing it approach, could easily have escaped from it. It began at length to whirl round with great rapidity, accompanied by a loud rattling noise. The effect of its amazing power was first exhibited upon a large stack of straw in the barn-yard, which it raised in one mass to a considerable height in the air. A beam of timber, lying flat on the ground, was hurled from its place several feet; and it will be thought almost to exceed credibility when it is mentioned that this beam was 33 feet long. Small stones were heaped together

together in mounds, as if by a flood. The farm offices were materially injured; some of them, indeed, were almost entirely stripped of their tiles. Human strength was mere weakness when opposed to this war of the elements. A stout young fellow, who had witnessed the scene in the barn-yard, from an apprehension that the house must necessarily be tumbled down, ran out for safety. The resistless enemy, however, lifted him over a wall five feet high, and carried him forwards 30 or 40 yards! Several of the servants were forcibly driven about, some in one direction and some in another, according to the eddy. The horses and cattle upon the farm exhibited the liveliest symptoms of alarm and agitation. The dwelling-house at Whitelaw, in which the family resided at the time, shook with such violence as to threaten its own destruction and theirs. Providentially, however, amidst all the devastation, no person was materially hurt; and, what renders this the more remarkable is, that the tiles which were torn from the surrounding offices fell from an immense height, in vast numbers, among the people exposed to the storm. Before the cloud reached the farm-house it had fortunately divided, and the two parts taking different directions, only one of them struck the buildings. Had the whole collected force discharged itself at once, few, it is probable, would have survived to relate the particulars. There was little rain at Whitelaw either immediately before or after the whirlwind; but in the adjacent country, to the north and east, owing, it is supposed, to the violent concussion of the clouds, there was such a torrent of rain, and, in some places, of hail for a few minutes, as had not been observed in the memory of man."

#### DEATHS.

After a few hours illness, on Saturday July 6th, at his house in Oxford-street, Rev. the architect; a man of great attainments in his science. He had followed the steps of Athenian Stuart in his travels through Greece and  
residence

residence at Athens, and had availed himself of all the advantages which might be derived from visiting the architectural remains in that part of the east. His collection of drawings, which were made during his oriental progress, are universally known to all the lovers of art and admirers of classic antiquity.

His principal work is the New Church at Southampton, which possesses great merit as it is; and would have been a very distinguished monument of his talents, if his original design had been completed; but he was curbed and controuled in its progress by his employers, the mayor and aldermen of that borough.

His plans for wet docks on the Thames, which were offered to the consideration of Parliament, display a very comprehensive knowledge of the various branches of his profession connected with such an undertaking. We have heard that he first suggested the conversion of the Isle of Dogs to that use to which there is an appearance that it will now be applied. These plans he sometimes thought of publishing, with large explanations and technical accounts of every part; but we know not how far he had proceeded, or whether he had proceeded at all, in fulfilling such an intention.

He was once tantalized with the flattering expectation of being employed at Bath in erecting a suite of buildings for a new arrangement of the public baths in that city. He accordingly made designs of great beauty and elegance, replete with convenience, full of rare contrivance, and disposed in an original style of accommodation. But this hope passed away, as Mr. Revely's hopes were very apt to do. He was also the Editor of the posthumous volume of Stuart's *Antiquities of Greece*, and was peculiarly qualified, by his local and professional knowledge, for that office.

He had been a pupil of Sir William Chambers, and, with all the subsequent advantages derived from travel and residence in Italy and Greece, it might have been supposed that he had a very fair prospect of success in his profession. But

Revely had an awkward way of letting loose his real opinions, and had habituated himself to an undisguised delivery of them. It need not be added, that such qualities were not calculated to render him popular, and that they influenced many who were disposed to employ him to seek architects of more pliant and accommodating dispositions.

He entertained a very high opinion of the profession of an architect; but it did not check his industry by any supercilious affectation of importance, for he sought employment wherever a liberal spirit would permit him to seek it. This activity, however, appears from some untoward circumstance or other to have been continually baffled. He once made a journey to Canterbury, with a set of admirable designs for a county infirmary, in consequence of an advertisement from the corporation of that city, which invited architects to make proposals for the erection of such an edifice. His designs were approved and admired; but after some consideration, the committee appointed to conduct the business proposed to purchase the drawings, and trust the execution of them to a country builder in order to save the expence of an architect. Mr. Revely, mortified at this treatment of his professional character, rather warmly, but very innocently observed, that to commit a work of such consequence to a common carpenter, when an architect was at hand, would be as injudicious as if any one, in a case of great danger, should apply to an apothecary when he could consult a physician. Now, it most unfortunately happened that the chairman of the committee was an apothecary; and Mr. Revely was astonished to find himself and his designs very unceremoniously dismissed, to make room for a builder who probably was not qualified to suggest such frivolous distinctions.

We cannot conclude without giving this accomplished architect the best praise that can be bestowed. He was a man of strict integrity in all his dealings; and the little eccentricities of his character had no tendency to weaken the main supporters of it.



In Vol. III. p. 335, we announced the death of the celebrated French astronomer Borda on the 20th of February last in the 64th year of his age. Since that period we have been able to collect a few more particulars respecting the service rendered by him to the sciences, which will no doubt afford satisfaction to many of our readers. Charles Borda, formerly Chevalier de Borda, was a *Chef d'Escadre* in the Royal Navy under the old French government. He distinguished himself early as an able mathematician, and many proofs of his talents in this respect may be found in the numerous and excellent papers which he published in the *Memoirs of the Academy of Sciences*. He wrote on different objects of hydraulics; on the resistance of fluids; on water-wheels and pumps; on the throwing of bombs; on the method of determining curved lines; on the properties of *maxima* and *minima*; on the best method of choosing by lot. In the year 1771 and 1772 he undertook a voyage, by command of the king, with Verdun de la Crenne and Pingré, in the *Flora* frigate, in which he had the rank of *Lieutenant de Vaisseau*, to various parts of Europe, Africa, and America, for the improvement of geography and navigation, and in order to try various nautical instruments and time-pieces. These three navigators afterwards published, in concert, the result of their observations, in two volumes quarto, under the title of *Voyage fait par Ordre du Roi en 1771 et 1772*, &c. in which Borda's share was not the least considerable. An account of the result of this expedition may be found also in the *Memoirs of the Academy of Paris* for the year 1773. The public are indebted to him likewise for the best chart of the Canary Islands, which served as a pattern for the valuable chart of these islands published in Spain in 1788.

In the year 1787 he published his valuable *Description et Usage du Cercle de Reflexion*, in which he revived the reflecting circle proposed by Tobias Meyer in 1756. He was the founder of the first school for Nautical Architecture in France, and drew up a plan of the mode of education to be employed

employed in it. He introduced also an uniformity in ship-building according to the principles of Euler, by which means all the French ships of war were so constructed as to be equal in point of sailing. The form of the French ships, which is founded on true mathematical principles, is undoubtedly superior to that employed by other maritime nations: it is the most convenient and advantageous for quick sailing, as has been acknowledged even by some of the best officers in the British Navy. He brought into use Meyer's old method of measuring terrestrial angles, which had been totally neglected; employed it in astronomical observations, and invented a circle on a new construction with moveable telescopes, which was used in the new measurement. He was the inventor of the new instruments with which that measurement was made, and of which some account has been given in the first volume, p. 269, of this Magazine. He had the greatest share in the late reform of weights and measures introduced in France; and caused to be printed, at his own expence, tables of signs according to the decimal system. In the year 1792 he determined, with an accuracy never before attained, the length of a pendulum swinging seconds, at Paris. In the year 1797 he stood on the list of candidates for the directorship.

The following anecdote is related of him when a young man:—Having presented himself before Camus, who examined the students in the Artillery School, as a candidate for admittance into the Royal Artillery, he was rejected on the score of incapacity. It was not long, however, before he was a colleague in the Academy of Sciences with his former examiner, who had entertained such a false opinion respecting him. Borda, however, either through a love of truth, or respect for his *quondam* judge, who was now his fellow-member, always contradicted this anecdote, and called it an idle rumour.

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**Errata.** In our last Number, p. 89, l. 14, for three read two. Page 90, 4th line from the bottom, read—that appear as if upon his body, and having, &c. Page 92, l. 23, for milla read metal.

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THE  
PHILOSOPHICAL MAGAZINE.

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AUGUST 1799.

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I. *Observations on the Property ascribed to Oil, of calming the Waves of the Sea.* By I. F. W. OTTO \*.

AN idea was entertained, in the earliest ages, that there were means capable of calming the waves of the restless ocean, and of rendering its surface tranquil and even. Aristotle says, that every body thrown into the sea when agitated, such as anchors, &c. tends to lessen the waves; because a kind of eddy is thereby created, which exerts itself in a direction contrary to their movement, and consequently weakens them. Plutarch † and Pliny ‡ ascribe this power to oil; as they assert that it possesses a property by which it restrains the restless movement of water, renders its surface even, and thereby causes the rays of the sun, which are refracted through the waves in different directions, to pass to the bottom free and uninterrupted. What the ancients have said on this subject is exceedingly vague and obscure. It

\* From Von Zach's *Geographische Ephemeriden*, Vol. II. Part 6.

† Quæst. Nat.

‡ Ea natura est olei, ut lucem adferat et tranquillet omnia, etiam mare, quo non aliud elementum est implacabilius. *Hist. Nat.* lib. ii. c. 103.

does not appear clearly from their information, whether the divers, to whose testimony they refer, made their observations at the surface of the water, or at any depth. Besides, we are not able to ascertain whether they looked through the oil as through a window, or as through a magnifying glass: for if a drop of limpid oil be let fall upon water, it will form a very simple kind of microscope, and magnify objects placed at a convenient depth below the water. Plutarch seems to believe, that the oil spouted from the mouth of the diver formed, in ascending, a kind of canal, which facilitated the passage of the light through the water\*.

Of this property of oil, apparently so wonderful, many testimonies were afterwards produced; and it was even consecrated by superstition for this purpose. Thus we are told, among the miracles of St. Cuthbert, that he gave a priest, for a sea voyage, some consecrated oil, by which he was enabled to allay the fury of the waves during a dreadful storm. Erasmus was acquainted with this property†; and at present it is not unknown among seamen, particularly in Holland.

Not many years ago, but before the celebrated Franklin communicated to the public his observations on this subject, the following article appeared in the *Annual Register*:—  
 “At the late fire in Thames-street it was observed that the oil, which, to prevent the farther spreading of the fire, had been thrown into the river, visibly calmed the violent agitation of the water. This property of oil,” says another paragraph, “appears to have been long known. It is ordered, by an old marine law, that when goods, during a storm, must be thrown overboard, if any part of the lading consists of oil, it shall be the first article thrown into the sea.”  
 In modern times we have a number of experiments which seem to leave no doubt respecting this circumstance. I shall

\* Canisius Lect. Ant. Vol. II. p. 8. ed. Bafn.

† His words are: Nonnulli procumbentes in fabulas adorabant mare, quicquid erat olei effundentes in undas. *Colloq. c recent. P. Rabi. Ulm.* 1747-8, p. 262.

here give an account of the most striking of them, without any fear of being thought too circumstantial, as experiments of this kind should all be decisive.

The inhabitants of the Bermudas employ oil in their fisheries, in order to render the water of the sea clear and transparent; and the Portuguese sailors, when they find the waves too violent on their entering the Tagus, pour a few flasks of oil into the water, by which means it is rendered calm, and their entrance becomes easy. The divers in the Mediterranean, when they labour under water, and when the sun-beams are prevented from penetrating to them by small waves, are accustomed to spurt a little oil from their mouths. One Gilfred Lawson, who resided several years at Gibraltar, relates, that the seamen of that place were accustomed to pour a little oil into the sea, in order that they might thereby be enabled to distinguish the oysters at the bottom; and that the same practice was followed on the whole Spanish coast. The same thing is done on the coast of Provence, and also by the inhabitants of the Hebrides. The Ragufans, with the like view, are accustomed to sprinkle oil over the water with a brush; and they give to the drops, under which the water becomes transparent, the name of windows. Tys Tiremann, a Dutch mariner, made an experiment of this kind during a storm, after he had lost his rudder and some of his sails, and, with six half ankers of oil, calmed the fury of the waves. A lieutenant of the name of May observed in 1735, during a storm, that the sea was calm and smooth around two ships laden with casks of oil, some of which were leaky; and an experienced seaman, named Bowerwyk, recommends, for securing boats which might be sent to the assistance of ships in distress, to throw into the sea, oil and other fat substances, and even beer. In a description of the shipwreck of a vessel called the Anna Cornelia, this property of oil is also celebrated; and some experiments made at Portsmouth, in the time of a storm, were attended with the best success. In the year 1736 Detouches de la Frenaye

saw an old sailer, by this method, save a ship which was on the point of foundering. One Day was indebted for his own safety, and that of his ship, to half a ton of oil. Linnæus\* learned from Gronovius, that the Dutch captains who frequented Greenland, and who were reproached with concealing this property of oil, always carried some casks of it with them when they went to the whale-fishery. The fishermen of the Texel carry oil with them for the like purpose. There is an instance of a herring-buss being saved by pouring out oil; while another, at the distance of two or three hundred fathoms, went to the bottom. Not only oil, under which is to be understood fat oil, such as olive oil, oil of rape-seed, and linseed oil, may be employed for this purpose; but also fat animal fluids, such as train-oil, &c. Ethereal oils do not possess the same property: a ship, for example, laden with oil of turpentine, which should employ it with the like view, would certainly fail in its end. This oil, however, diffuses itself very speedily over the surface of the water; but the covering it forms is so thin that it is separated by the smallest external force.

At Yarmouth the sailors are unanimously of opinion, that fat substances thrown into the sea prevent the agitation of the waves. Pennant† mentions an observation made respecting seals by the fishermen in Scotland. When these animals eat any fat fish, the sea in their neighbourhood is uncommonly still; a circumstance which induces them to search for them in such places. Sir John Pringle learned in Scotland, that the fishermen could discover at a great distance places much frequented by herrings, as the sea, by the oily fatness which these fish emit, has no apparent movement. It is observed at Rhode Island, that the water in the harbour of Newport is always calm and still as long as the Greenland ships remain there at anchor. The cause of this is ascribed

\* Reise durch Westgothland, p. 304.

† British Zoology, Vol. IV.

to the sea-nettle, a kind of vegetable sea-worms from oily substances, which are thrown together in the hold of the ships, and the oil that oozes through between the staves of the casks, which, of course, is pumped out with the bilge water. Seamen have also observed, that the motion of a ship, the bottom of which has been newly payed, occasions much less agitation in the water than that of another which has not been daubed over with tar for a long time. Such instances, of which several more equally decisive might be produced, are sufficient to authorise this use of oil, in opposition to those who pretend that it can be employed only in ponds and other pieces of water of small circumference, where, by diffusing itself over a mass of water not much swelled up, it can easily produce a tranquil surface.

These facts seem to have been unknown to Dr. Franklin until he had an opportunity of making similar observations himself. On his passage from England to America some person told him that he had thrown into a lake a vessel containing oil in which flies had been drowned; that the flies, which were apparently dead, began in an instant to move, and went round with a circular motion on the surface of the water. Dr. Franklin ascribed this movement to a repulsive power maintained by the oil, which gradually issued from the spongy bodies of the flies. In the year 1757, being at sea in the middle of a fleet consisting of ninety ships destined for Louisburg, he observed that the movement of the water was in one part of the fleet calm and uniform, while the water between the other ships was thrown into great agitation by the wind. As he could not at that time discover the cause of this phenomenon, he asked the captain of one of the ships, who replied, that the cook had, no doubt, thrown out the greasy water, which must have rendered the sides of the ship oily.

Franklin now paid more particular attention to this circumstance; and as he found that a drop of oil diffused itself

speedily over a large space of water, so that it formed a thin covering to it, which reflected prismatic colours, he resolved to make some farther experiments; and though they did not all succeed according to his wish, he declared himself convinced of the truth of the phenomenon.

One of these experiments I must here mention; for, though it does not appear very favourable to his ideas respecting the efficacy of oil in calming the waves, it at any rate shews that oil has a great influence on the motion of water. He discovered that oil excites on the water a kind of waves, under circumstances when neither water alone nor oil could produce the like. He suspended a glass half filled with water, and having made it to swing backwards and forwards, after the manner of a pendulum, the water remained at perfect rest. The case was the same when the glass was half filled with oil; but as soon as he had poured oil upon the water, and continued the swinging of the glass, the surface of the vibrating oil remained smooth and even, while the water below it was thrown into a regular agitation like that of the billows of the sea,

Franklin considers this phenomenon, which I have confirmed by experiments, to have in it something singular, and difficult to be explained. The cause of it, however, may perhaps lie in the difference of the specific gravities of these two fluids, by which they are susceptible of the impulse to movement in different degrees; and by the effort which the oil makes, on account of its lightness, to occupy the upper place on the surface, the water is violently agitated.

When a drop of oil is poured upon water in a state of rest, as for example in a basin, a fine vapour immediately arises and covers the surface of the water. It emits coloured rays, and disperses small bits of paper thrown upon the spreading drops. When the space on which the drop falls is small, it does not spread itself; but seems, as it were, to be attracted towards its centre. When a bit of paper, twisted together  
in



in a conical form, and soaked in oil, is thrown into water, the fluid which issues from it causes it to turn round with a rotary motion on its centre.

In an experiment which Franklin made on a small lake, the surface of which was raised into large waves by the wind, the oil spread itself with great velocity, but it did not moderate the waves. The reason of this was, that he poured out the oil at the leeward side of the lake. He therefore went to the windward side, where the waves originated; and there a small quantity of oil produced, in the space of several square rods, a calm, which gradually extended farther until it reached the other end of the lake; and this whole part of it, for the extent of half an acre, soon became as smooth as ice.

Of the various explanations given of this phenomenon, the following appears to be the most natural, if not altogether satisfactory:—The air and water have an affinity for each other, and they unite in a mechanical and chemical manner when they come in contact. It is well known that air always exists in water; that the latter can be freed from it under the receiver of an air-pump; and that, when the water is again exposed to the air, it absorbs a like quantity of it. When a mass of air presses, therefore, on the surface of a body of water, it combines itself in part with it, and forces it along with it. Now, if oil be poured upon water, the particles of the former attract each other with too great force to admit of their uniting with the water or the air. By the covering which the oil forms on the surface of the water, the latter is prevented from coming into contact with the air; and the wind is conveyed over its surface, without being able to force its way into it, and to raise it into waves.

The spreading of oil in water is ascribed by Dr. Franklin to a repulsive power which they both exercise against each other; but it is very evident that this explanation is far from being satisfactory. Even if such a power actually existed, and if the particles of the oil exercised a repulsive power

against the water, and an attractive power among themselves, they would be prevented from spreading, in an uniform manner, over the surface of the water: they would rather form insulated globules; and, as they touch the water, would equally recede, and proceed towards the bank or any other solid body. Oil, therefore, as it is lighter than water, must float on its surface when poured upon it, and, according to the laws of hydrostatics, endeavour to extend itself in a lateral direction; and on account of the strong adhesion of its particles, must form an extraordinary fine and continued stratum on the surface of the water. This diffusion, however, supposes that the surface of the water is horizontal: it therefore seems to follow, that the whole power of the oil consists in preventing the formation of new waves in the places on which it has been poured; but that it cannot be in a condition to disperse those which have been already formed. The billowy agitation of water supposes that some part of its surface has been previously raised. Bodies which float upon it oppose this rising by their gravity, consequently the billowy movement, and in part destroy it.

It appears therefore, to some philosophers, that this celebrated property of oil does not consist so much in its fluidity and toughness, as in its being a lighter body than water. From this it would follow, that all bodies lighter than water, and at the same time more distended, such as drops or masses formed by oil, must produce the same effect, but in a higher degree. Achard recommends for this purpose close leathern vessels, through which the water cannot penetrate; or, what would be still better, tin-plate boxes of from six to eight feet content in the base and two feet in height, which must be filled with air, but rendered impenetrable to water. Ships, he thinks, without much increasing their lading, might always carry with them some dozens of these vessels or boxes, to be thrown overboard, fastened to the ship with ropes, in case the agitation of the water should threaten danger. Achard made experiments, on a small scale, with tin-plate boxes of

this kind, which were attended with the wished-for success as when he employed oil: we know also, from the information of Scheldemung, that the whirlpool of the Maelfrom has been moderated by throwing pieces of wood into it.

To form a decisive opinion respecting the utility of these means, it would be necessary to make experiments upon a large scale. At present oil appears to me to deserve the preference, as it produces the effect, not only by its being a lighter body, but also by its fluidity and toughness: besides, it possesses this advantage, that a small quantity of it is sufficient to spread over a considerable surface of water.

It has been objected against this use of oil, that the calmness produced by it has been observed to be only of short duration, and that the sea afterwards redoubles its fury; also, that a vessel which follows a ship sailing through water calmed by the above means, is exposed to so much greater danger; but of this circumstance no testimony of sufficient authority has been adduced\*.

II. *Communication from Dr. MITCHILL, of New-York, shewing the Utility of constructing the Houses and paving the Streets of Cities with calcareous in preference to siliceous and argillaceous Materials.*

SIR;

New-York, June 6th, 1799.

IF you think the inclosed letter of any importance, I wish you would insert it in the Philosophical Magazine. It is so

\* Transactions of the Society of Manchester, Vol. II. Achard's *Sammlung physikalischer und chemischer Abhandlungen*, Vol. I. Berlin, 1784, p. 83. *Essay sur les moyens de diminuer les dangers de la mer par l'affusion de l'huile, du goudron, ou de quelque autre matiere flottante*, par M. de Helyveld, Amst. 1776. Letters and Papers on Philosophical Subjects, by Franklin, p. 438. *Meister de celebratis olei aquæ supersufi effectibus opticis et mechanicis*, 1778.—The last work treats more on the testimony of the Ancients, than on the experiments that have been made.

perfectly

perfectly consistent with the principle I have for some time been led to receive as true, that I wish for its extensive circulation.

Yours with esteem and regard,

MR. TILLOCH.

SAM. L. MITCHILL.

*Copy of a Letter from Hippolyto I. Da Costa, Esq. Brazilian.*

“ DEAR SIR,

*New-York, May 21, 1799.*

“ YOUR theory, in regard to the action of *alkalis* and *calcareous earth* upon septon, or the principle of corruption, is so well proved in the several papers you have published, that it is needless to adduce further proofs to persons of knowledge: but as additional facts may be useful to persuade people of less information or more prejudices, I believe I agree with your wishes in presenting to you an account of the influence of calcareous earth upon the putrid effluvia in the city of Lisbon, which is, I think, a proof of the most interesting nature.

“ The city of Lisbon is situated on the northern bank of the river Tagus, about eighteen miles from its mouth: it is about six miles in length, and its breadth is in some parts two, in some three miles, although in other parts very narrow. In the most inhabited part of the city there are seven hills or mountains, which, of course, occasion declivities and lower situations. This city may be divided into the *new* and *old* city; because there is a spot which was overthrown by the horrible earthquake of the year 1755, and was rebuilt: I call, therefore, this part the new city. The streets in this quarter are very regular, the buildings neat, and the pavements for foot passengers very commodious; but the situation is almost all very low.

“ The old city, or the part which did not suffer so much in the earthquake, and preserves its ancient buildings, is in the Gothic taste, with narrow and crooked streets, in the most of which there are no pavements for foot passengers; the houses are so high, that, in some of the narrowest streets, the sun cannot

cannot be seen but two or three hours every day, viz. from eleven before noon to one after noon. In the new city there are gutters or sewers below the earth to conduct the water and impurities from the houses and streets to the river; but in the old city there are none of these.

“As the houses are, in general, five or more stories high, and the streets narrow, it is easy to conceive the thickness of population, and, of course, the vast quantity of impurity that comes into the streets every day, which, with the water and other liquids poured in likewise, keep always there a vast quantity of dirt. A great sum of money is appropriated, I know, and some pains taken, to preserve the cleanliness of the city: but without entering into the discussion how this money is employed or disposed of, which is but very little interesting to our present inquiry, it is true that very often I have been obliged to make a great turn to go a short distance, because it was impossible to cross the street through the dirt; and very often I have seen dogs, cats, and other dead animals, lie in the streets.

“There is in every house (chiefly in the new city) a privy, with a canal which goes up to the highest story; because, as the several stories are inhabited by different families, they want such a convenience in every one: but this canal emits always a very bad smell, by the accumulation of impurities within its walls, which, from the form of its construction, cannot be washed but with water let in by a small orifice or hole. There is also, in many houses, a place in the inside of the street-door for making water, which contributes its portion of bad smell; and the houses are in general not very clean.

“Besides all these sources of putrid exhalations, there are a great many wharves, and much naked shore, which, being uncovered by the ebb-tide, present to the sun a surface covered with dirt and sea-weeds undergoing putrid fermentation. The mouths of the sewers I have mentioned above go to the wharves, and are likewise bare at low water. The fluid

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which

which comes from these sewers contains so many infecting matters, that its strong putrid smell can scarcely be endured.

“ After this short description of the police of Lisbon, in regard to its cleanliness, every body would draw the inference, that endemical diseases must reign, not only in the summer, but in the winter time, seeing that the accumulation of the dirt in the streets is incomparably greater in the winter than in summer. The connection there is between malignant distempers and dirtiness is very well known, and expressly marked by Tissot (*Avis au Peuple sur la Santé*, chap. ii. § 7). Happily, Sir, the contrary is the fact: Lisbon is one of the most healthy situations I know, and its inhabitants do not suffer but the *common* diseases to which the human body is subjected. Many people go from England and other countries to Lisbon, in certain diseases, to enjoy the benefit of a salubrious place, and very often to spend the summer agreeably in a good and wholesome climate.

“ What then can be the cause of this apparently physical contradiction between the impurity and corruption in the streets, and the salubrity of the air? I confess, Sir, I cannot find any explanation of this phenomenon if I reject the theory of the influence of calcareous earth upon septic fluids, and I can well comprehend the reason if I admit it.

“ The buildings in Lisbon are all of stone, and, in general, of marble of several qualities, and chiefly the marmor rasilis of Linnæus; and this stone is procured in the neighbourhood of the city. All the houses are white-washed inside and outside; and the handsomest new-fashioned houses are plastered with a plaster they call *escariola*, a compound of gypsum and other matters, and painted over that composition in water-colours. As a number of new buildings are continually erecting, there are, in all the streets, a great many stone-cutters hewing the stones, and their fragments are scattered through the streets. In the time of the earthquakes, as the houses fall down, the attrition of the stones, one against the other, breaks them in pieces, reducing many

to a powder. The pavements for the foot passengers are of large marbles; and, in many parts, the soil is calcareous too: in other parts, as the streets are paved with small round stones or pebbles, the accumulation of the calcareous powder makes a firatum above the surface of the streets and public places. When the wind blows hard, there is so great a quantity of calcareous powder flying about that it is inconvenient to the eyes, and sometimes is so fine that it comes into the houses even when the windows and shutters are shut up.

“ Now, to what can I impute the healthiness of that city but the quality of its calcareous earth? which neutralizes the putrid exhalations, or septic acid, which impregnates the atmosphere, and thus prevents its bad and fatal effects, preserving that city, which otherwise would be the fountain of pestilence, and the anti-chamber of death.

“ As no other cause can be discovered of the healthiness of Lisbon, amongst its continual putrid infection, recourse may be had to the climate, and to the temperature of the atmosphere: but I believe it can be sufficiently proved, that the cause is the influence of the calcareous earth, and not of the climate; because, if this salubrity was owing to the climate, all the neighbourhood of Lisbon, which enjoys the same climate, would enjoy the same healthiness: but this is not the case. On the opposite bank of the Tagus, over against Lisbon, there are three or four villages, called Almada, Caparica, and Cassilhas, situated on small hills, and surrounded by beautiful farms: the buildings there are in general of siliceous stones, the soil is sandy and in some parts clayey, and the streets in these villages infinitely cleaner than in Lisbon; but intermittent and remittent fevers prevail in these villages and their neighbourhoods almost every summer, while in the mean time Lisbon is perfectly free. Near the other part of the river, in the neighbourhood of Lisbon, on the shore of the ocean, there are other small villages, as Cintra and Collares, from whose neighbourhoods the stone  
of

of the Lisbon buildings comes, and the soil is in a great part calcareous. These places are pointed out as the seat of health, and, indeed, are the most beautiful and pleasant summer retreats you can imagine.

“After this statement, can any body attribute the salubrity of Lisbon to its climate merely? Certainly not: because I observe, that where there is calcareous earth there is no infection, notwithstanding the continual existence of putrid exhalations; and where there is not calcareous earth, and the soil is sandy, gravelly, and clayey, there are fevers, although the climate is the same; the distance of these places being only the breadth of the river, about three miles.

“To these unanswerable facts I must add, that I have observed, two or three times, in Lisbon, dead animals upon the ruins of houses, and of course surrounded with calcareous earth, in a state of desiccation; and, at the same time, two or three fathoms distant, another animal dead too, and lying upon another kind of soil, in a state of complete putrefaction. The reason of their preservation is obvious: the septic acid was absorbed by the calcareous earth as soon as it was formed by the union of septon with oxygene; likewise, the oil formed by the union of their hydrogen with carbone has been imbibed, the water formed by the junction with oxygene evaporated, and the remaining parts of the animal were left in a dry state.

“The effects of calcareous earth and alkalis seem to be very well understood by the people of Portugal: they put chalk and plaster with the bodies they bury in the churches; and they wash with plaster the rooms where there have been any sick or contagious disorders. This precaution they never omit.—I pray you to accept my best wishes.

“I am, dear Sir,

“Your’s, very sincerely and affectionately,

“HIPPOLYTO I. DA COSTA.

“SAMUEL L. MITCHILL, Esq.”



III. *An Account of Mr. BROWN's Travels through Egypt and Syria, &c.\**

MR. BROWN arrived in Egypt on the 10th of January 1792, after a passage of twenty-six days. Some information which he obtained in Alexandria having induced him to attempt exploring the vestiges of the temple of Jupiter Ammon, he procured an interpreter, and made the necessary arrangements for the conveyance of his baggage and provisions, with some Arabs, who are employed in transporting through the desert dates and other articles between Siwa and Alexandria. In this business he was much assisted by Mr. Baldwin, who readily entered into his views, and did every thing in his power to promote their success.

On the 24th of February Mr. Brown, accompanied by the Arabs, left Alexandria, and travelled the first day only about eight miles. From that period till the 4th of March their route lay along the coast, and they were never long out of sight of the sea. The soil was generally smooth and sandy, and the vegetation was very inconsiderable; the greater part consisting of different kinds of glass-wort or *kali*, which, however, afforded a seasonable relief to the suffering camel. For their horses they were obliged to carry a constant supply of barley and chopped straw. There are several kinds of preserved meat prepared among the orientals for long journeys. They obviate the inconveniency of salt provision by using clarified butter. The kind most used is called *mishli*, and will keep good for many years. It is brought from western Barbary to Kahira (Cairo).

On Sunday the 4th, having travelled about six hours, they arrived at a well where they found a copious supply of water; and, having refreshed their camels, they left the coast, and proceeded in a south-west direction. From Alexandria to this well the time employed was about seventy-

\* Extracted from the Account of his Travels just published.

five hours and a half. As they had little hope of finding any more water between that and Siwa, they were obliged to use all possible diligence on the route, so that they arrived there on Friday the 9th at eight in the evening.

Siwa, which answers the description given of the Oazes, is a small spot surrounded on all sides by desert land. It was about half an hour from the time of their entrance on this territory, by a path bordered with date-trees, that they arrived at the town which gives name to the district. They dismounted, and seated themselves, as is usual for strangers in that country, on a *misjed*, or place employed for prayer, adjoining to the tomb of a *Marabût*, or holy person. In a short time the chiefs came to congratulate them on their arrival, after which they conducted them to an apartment, not indeed very commodious, but the best they were provided with; and, after a short interval, a large dish of rice and some boiled meat were brought in, the schechs attending while the company was served, which consisted of Mr. Brown's interpreter, his conductor, two other Bedouins, their companions, and himself.

It being discovered that Mr. Brown, though in the Turkish dress, was a Christian, he experienced some bad treatment from the populace, and was obliged to confine himself to his apartment for two or three days. On the fourth, however, he was allowed to walk abroad and to observe what was remarkable in the place. Having walked about two miles he arrived at what they called the Ruins, or *Birbé*; and was surprised at finding himself near a building of undoubted antiquity, and, though small, in every view worthy of notice. It was a single apartment built of massy stone of the same kind as those of which the pyramids consist, and covered originally with six large and solid blocks that reach from one wall to the other. The length he found thirty-two feet in the clear, the height about eighteen, the width fifteen. A gate, situated at one extremity, forms the principal entrance; and two doors also, near that extremity,  
open

open opposite to each other. The other end is quite ruinous; but, judging from circumstances, it may be imagined that the building has never been much larger than it now is. There is no appearance of any other edifice having been attached to it; and the less so, as there are remains of sculpture on the exterior walls. In the interior, there are three rows of emblematical figures, apparently designed to represent a procession; and the space between them is filled with hieroglyphic characters properly so called. The *sceffit* is also adorned in the same manner, but one of the stones which formed it is fallen within: the other five remain entire. The sculpture is sufficiently distinguishable; and even the colours in some places remain. It was mentioned to Mr. Brown, that there were many other ruins near; but after walking for some timewhere they were described to be, and observing that rough stones, apparently detached from the rock, were pointed out to him as ruins, he returned fatigued and dissatisfied. The *schechs* had prepared for them a dinner in a garden, where they were unmolested by intruders; and the sun being then near the meridian, Mr. Brown took the opportunity of observing its altitude by means of an artificial horizon. The result was not materially different, though in the sequel he repeated his observation: it gave N. L.  $29^{\circ} 12'$  and a fraction; the lon. E. F.  $44^{\circ} 54'$ .

Mr. Brown having found a monument so evidently Egyptian in this remote quarter, entertained greater hope of meeting with something more considerable by going farther, or of being able to gain some information from the natives, or the Arabs, that would fix exactly the position of the remains, if any such there were, of the far-famed temple of Jupiter Ammon. He therefore applied to three of the *schechs* who had shewn themselves most friendly towards him and his attendants, and having enquired whether they knew of any ruins farther to the westward or south-west, one of them replied that there was a place (*Arajchié*) where there were ruins, but that it was impossible to approach it, as it was

furrounded by water, and there were no boats. Mr. Brown soon found, from the description, that *Arafchié* was not the Oasis of Ammon; but, conceiving it something gained to pass farther west, he determined to proceed thither. For this purpose it was necessary to use all possible secrecy, as the Siwese were bent on opposing his farther progress. An agreement was therefore made with two persons of the poorer class of the natives, for a few zechins, that they should conduct him and his attendants to *Arafchié*, and that, if what they sought for was not there, they should proceed with them to the first watering place that they knew of directly to the southward. The remainder of the time he stayed at Siwa was employed in combating the difficulties raised about his departure; and it was not till Monday, the 12th of March, that he was enabled to commence his journey west.

The Oasis, which contains the town of Siwa, is about six miles long, and four and a half or five wide. A large proportion of this space is filled with date-trees; but there are also pomegranates, figs and olives, apricots and plantains; and the gardens are remarkably flourishing. The inhabitants cultivate a considerable quantity of rice, which, however, is of a reddish hue, and different from that of the Delta. The remainder of the cultivable land furnishes wheat enough for the consumption of the inhabitants. Water, both salt and fresh, abounds; but the springs which furnish the latter are most of them tepid; and such is the nature of the water, air, and other circumstances, that strangers are often affected with agues and malignant fevers. One of those springs, which rises near the building before described, is observed by the natives to be sometimes cold and sometimes warm. After the rains the ground in the neighbourhood of Siwa is covered with salt for many weeks.

Mr. Brown, having left his temporary residence, proceeded, himself and interpreter on horseback, his original conductor on foot, and the two men he had hired each on an ass; but he had not gone far before one of the latter told him that it  
would

would be necessary to return, as the people of the town were in pursuit of them, and would not permit them to go and disinter the treasures of *Arafchié*. They nevertheless continued their journey for two days, and at the end of that time arrived at the place described to them. It was not far from the plain of *Gegabib*. Mr. Brown here found an island in the middle of a small lake of salt water, which contained mis-shapen rocks in abundance, but nothing that he could positively decide to be ruins; nor was it very likely that any such should be found there, the spot being entirely destitute of trees and fresh water. Mr. Brown, however, had the curiosity to approach nearer to these imaginary ruins, and accordingly forced his horse into the lake. The horse, from fatigue and weakness, or original inability to swim, soon found himself entangled, and could not keep his head above water. Mr. Brown fell with him, and was unable to detach himself; and when he at length found himself on dry ground, the circumstances he was under prevented him from making any farther observation on this island and lake.

After visiting this place, Mr. Brown and his attendants continued their journey south according to the agreement made with the guides, but found the pursuit equally fruitless. At the end of the third day, having arrived in lat.  $28^{\circ} 40'$ , or nearly so, they became much distressed for water: they remained a whole night in suspense concerning their destiny, when at length a supply of that necessary refreshment was found. As they did not, however, discover any thing that bore the least resemblance to the object of their search, they were obliged to think of returning, which they did; and, falling into the straight road from Siwa to Alexandria, arrived at the latter on the 2d of April 1792\*.

Mr. Brown, after remaining some time at Alexandria, to

\* Mr. Brown says, that an opinion has been communicated to him, that Siwa is the *Siropani* of Ptolemy, and that the building described was probably coeval with the temple of Jupiter Ammon, and a dependency on it. D'Anville supposes Siwa to be Marcotis.

recover from the effects of his journey, commenced, on the 1st of May, another to Raſhid, where he ſtaid five days; and on the 6th of May embarked with a view of proceeding to Terané, a town ſituated on the left of the moſt weſtern mouth of the Nile, at a very ſmall diſtance from the river. From Terané Mr. Brown made an excursion to view the lakes which produce natron, and to obſerve that production in its naſcent ſtate. One of them was very irregular in its form, ſo that it was not eaſy to ſay what might be the quantity of ground covered with water. It is higher in winter than in ſummer; and, at the period when Mr. Brown viewed it, he could no where diſcover that the breadth of it exceeded a mile: its length might be nearly four. Towards the end of ſummer theſe lakes, it is ſaid, are almoſt dry, and the ſpace from which the water has retired is then occupied by a thick depoſition of ſalt. Not far from the eaſtern extremity a ſpring riſes with ſome force, which much agitates the reſt of the water. Cloſe to the ſpring the depth was far greater than our traveller's height, in other parts it did not generally exceed three feet. The thermometer near the ſpring ſtood at 76, while in the open air it was at 87. The more weſtern lake differs not materially from the eaſtern, in ſize, form, or productions: the colour of the water in both is an imperfect red, and, where the bottom is viſible, it appears almoſt as if covered with blood. Salt, to the thickneſs of five or ſix inches, lies conſtantly in the more ſhallow part. How thick the ſubſtance of natron commonly is in the lake, Mr. Brown did not accurately determine; but thoſe employed to collect it, reported, that it never exceeded a cubit or common pike. Having ſpent two days and part of a third in the vicinity of the lakes, Mr. Brown's attendants grew tired, and he was obliged to return. After a ſhort interval he embarked for Kahira, and arrived there on the 16th of May 1792.

Mr. Brown being determined to undertake a journey to Abyſſinia, employed the greater part of the ſummer, which  
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he spent at Kahira, in learning the Arabic language; but still judging that he should have occasion for an interpreter, he took care to provide a Greek, who, besides his native language, was acquainted with the Turkish, Arabic, and Italian: he had also with him a Mahomedan of the lower class of the Kahirines, who, as belongs to that character, was prepared for every office. Thus provided, he set out by water on the 10th of September, and on the 8th day reached Assiut. Having spent about fourteen days here waiting for a boat, he was at length able to hire one of a moderate size; and leaving Assiut on the 4th of October, arrived on the 11th at Girgi, formerly the capital of Upper Egypt. On the 17th he arrived at Dendera, the ancient Tentyra, where he saw the noted temple, the most perfect specimen of Egyptian architecture now remaining. It is in the form of an oblong square, 200 feet by 150, Pococke says 145, and is now almost buried in the sand. The same night, about twelve, he reached Ghenné, the ancient Cœne or Cœnopolis; and on the 23d came to Akfôr, the ancient Thebes. After passing three days in and around these ruins, Mr. Brown proceeded on his voyage up the Nile, and on the 31st arrived at Assûan, the ancient Syene, where he remained three days, contriving, if possible, to pursue his route up the river; but a war having arisen between the Mamlûks of Upper Egypt and the Cashef of Ibrim, no one was suffered to pass from Egypt to Nubia. The caravans had all been stopped for many months, and not even a camel could be procured. Our traveller being therefore constrained, with deep regret, to abandon his design of penetrating to Abyssinia by this route, gave up all hope for that season, and began to think of returning.

Mr. Brown, therefore, left Assûan on the 4th of November 1792, and, proceeding rapidly down the Nile, arrived at Ghenné on the 7th. From Ghenné he made a short excursion to Cossir; but he did not think it advisable to stay long there, as the people were highly incensed at that time

against the Franks on account of the following circumstance, which had taken place there three or four years before. An English vessel, commanded, as is said, by a Captain Mitchell, having moored there, a quarrel arose between the crew and the natives respecting a supply of water, which is a commodity difficult to be procured. From a violent contention blows ensued, and the captain thought himself justified to fire upon the town; in consequence of which several persons, some say fourteen, were killed, and much damage done. The natives were exceedingly exasperated, and swore to sacrifice the first Englishman that should fall into their hands. Mr. Brown found little to reward him for exposing himself to the danger of this excursion, except the sight of some curious rocks, which he thus describes:—The roads we travelled in going to Cossir, as well as in returning, have something in them very remarkable: the rough and lofty rocks of granite and porphyry, with which it is on all sides environed, have a magnificent and terrific appearance; and the road between them, which is almost level throughout, gives the idea of immense labour in cutting it. All these circumstances concur in testifying the importance Cossir must once have had as a port. In the route we took in going, at certain distances, on the highest rocks, is observable a succession of small structures, formed with uncemented stones, and which, by the marks of fire within them, seem to have served as signals. These are numerous, but they are too rude to enable one to fix any time for their erection. They appear to me to be pretty ancient. The red granite is in vast quantities; and the chain of rocks, consisting of that substance, appears to extend itself in a north and south direction. Huge rocks of porphyry, both red and green, are distinguishable; and, as appears, more of it in the road we pursued in going than in that by which we returned. I observed ruins of alabaster in both, but particularly in returning. The *verde antico*, it was long before I could discover; at length I found it in returning, by the signs Bruce had described. In short,

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the route unfolds a treasure of marbles that astonishes the beholder, and demonstrates, that, on any future occasion, the quarries may be again wrought, and modern architecture equal that of the best ages of Greece or Rome as to richness and durability of ornament, if ever it shall in justness of proportion, simplicity of taste, or unity of parts in one sublime whole, which, indeed, seems sufficiently problematical. On the 21st of November Mr. Brown returned to Assiut, and on the 30th set sail for Kahira, which he reached on the 8th of December.

[To be continued.]

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IV. *Means proposed for saving the Crews of Vessels Shipwrecked near the Coast. By an anonymous Author\*.*

EIGHT or nine years ago, being much struck by an account which I read of the shipwreck of twenty-four persons who perished so near the shore that their cries could be distinctly heard, an idea immediately occurred to me, of endeavouring to discover some means proper for saving the crews of shipwrecked vessels, at least under such circumstances, that is to say, at the distance of forty or fifty fathoms from the shore; for I did not then imagine that it could be done at the distance of two or three hundred, as I afterwards discovered. I perceived at first that the only means to save the crew of a vessel in such a state, would be to establish a rope of communication from the shore to the ship. After examining a number of means, both ancient and modern, I fixed on a bomb or cannon-ball (a bomb I think preferable), to which should be fastened the end of the rope, extended afterwards in a zig-zag direction before the mortar or cannon, or suspended on a piece of wood raised several feet. But as it was necessary to know if the cord would not break by the

\* From a late French Journal.

force of the explosion and the velocity of the motion, I thought it proper to consult professional men. I wrote to some officers of the artillery in garrison at La Fere, and they almost all replied that the rope would infallibly break.

Not satisfied with this answer, I happily conceived the idea of making the experiments on a small scale. I caused a piece of the barrel of a musket to be filed into the form of a small mortar of 18 lines in length internally; and having tied a packthread to a common ball of lead, I made an experiment, which perfectly succeeded, as did a great many others which I repeated afterwards even with the strongest charges of powder. I communicated this success to these officers of artillery, who replied, that there was a great difference between a quarter of an ounce of powder and four or five pounds employed for a bomb; and, in short, that the rope would break.

Being desirous to ascertain what truth there might be in this assertion, I repaired to a large iron furnace, where I remained ten days, and where I caused a mould to be formed for a four-inch mortar and a bullet of the same calibre: I had them both cast, and made an experiment with a rope three or four lines in diameter and eighteen ounces of powder, which succeeded. I then came to Paris, where, after staying eight months, I obtained an order from government to make my experiments on a grand scale even at La Fere, where I had to expect men prejudiced against the success of my attempts. When I went thither they persisted that they would not succeed. I knew, however, what I had to depend upon, as I had already made experiments. In short I repeated them, and they completely succeeded. The first day, nothing being done in a proper manner, some of the experiments failed; but things being arranged better next morning, we repeated them seven times without once failing, viz. four times with a mortar of eight inches, and three with one of twelve, augmenting each time the charge of the

the powder from the weakest to the strongest. The spectators having judged that this number was fully sufficient to establish the truth of the discovery, no more were made.

I shall now proceed to other means, which I have devised not only for saving the crews of vessels, but also the greater part of the cargoes when exposed to danger near the coast.

1st, It must be remembered, that, in such circumstances, the only thing necessary is to get a cord of communication conveyed to the vessel in danger. It ought to be remembered also, that a vessel is never cast away or perishes on the coast, but because it is driven thither against the will of the captain, and by the violence of the waves and the wind, which almost always blows from the sea towards the shore, without which there would be no danger to be apprehended: consequently, in these circumstances, the wind comes always from the sea, either directly or obliquely, and blows towards the shore.

A common paper kite, therefore, launched from the vessel and driven by the wind to the shore, would be sufficient to save a crew consisting of 1500 seamen, if such were the number of a ship of war. This kite would convey to the shore a strong packthread, to the end of which might be affixed a cord, to be drawn on board by means of the string of the kite; and with this cord a rope, or as many as should be necessary, might be conveyed to the ship.—It may be readily conceived that I cannot here enter into any detail concerning various circumstances relating to this subject which it might be necessary to mention.

2d, A small balloon, of six or seven feet in diameter, and raised by rarified air, would be also an excellent means for the like purpose: being driven by the wind from the vessel to the shore, it would carry thither a string capable of drawing a cord with which several ropes might be afterwards conveyed to the vessel. Had not the discovery of citizen Montgolfier produced any other benefit, it would be entitled on this account to be considered as of great importance.

3d, A

3d, A sky-rocket, of a large diameter, would be of equal service. It would also carry, from the vessel to the shore, a string capable of drawing a rope after it. C. Ruggieri, whom I have consulted on this subject, told me, that he made some four inches in diameter, which rose to a great height; and that, with a string attached to them, they would go to the distance of four or five hundred fathoms, which is more than would be necessary. They may be kept in a state fit for service two years, if deposited in a dry place.

Lastly, A fourth plan for saving the crew of a shipwrecked vessel, is that of throwing from the vessel into the sea an empty cask with a cord attached to it. The wind and the waves would drive the cask to the shore, and afford the means of establishing that rope of communication already mentioned. Each of these methods may be improved, but I cannot at present enter into any detail\*.

V. *On the different Kinds of Cadmia, and particularly those of Zinc and Cobalt.* By I. I. BINDHEIM of Moscow †.

THE surest method of classing minerals is without doubt to arrange them, not according to their external characters, but according to their internal component parts. For, though the former in some measure serve for discrimination, and are therefore not altogether useless, they are not so precise and certain as to form a basis for a system of mineralogy,

\* The author of the above papers says, that he announced his discovery in the *Affiches de Paris* on the 29th of January 1794. However this may be, we know that one of his methods, that of conveying a rope to the shore, by attaching it to a bullet or bomb to be afterwards fired from a cannon or mortar, was proposed a few years ago by a serjeant or officer of artillery at Woolwich, named Bell. Some experiments of the same kind made at Portsmouth, we believe, answered expectation. The use of a kite or rocket seems to deserve attention; and we do not hesitate to say, that the former could hardly fail of producing the desired effect. At any rate it might be easily tried. EDITOR.

† From *Neue Nordische Beyträge*, by Professor Pallas, Vol. VI.

since

since the attentive naturalist is sufficiently taught, by experience, that in the mineral kingdom substances of the same genus, though different in external form, consist often of the same component parts; and that other bodies of the like kind differ in their component parts, though perfectly alike in their external appearance. As this is the case, we can find no better guide to conduct us to an invariable classification, arrangement, and definition of mineral bodies than chemistry; a knowledge which must be united with that of the external characters of minerals.

To give an instance of the uncertainty which arises when these are separated, I shall here mention those ores which are known by the name of *cadmia*; for it would seem, by the many improper denominations which are often founded on their external characters, as if we were almost conducted back to the dark age of Cadmus, from whom the Europeans are said to have first learnt the art of fusing ores on a large scale, and from whom, in all probability, the term *cadmia* had its origin. In this respect chemical knowledge is a better guide than external characters, and the names thence deduced, and often very improperly; it enables us to define minerals with more accuracy, and conducts us nearer than the latter to the real knowledge of nature in this department, without which all mineralogical knowledge must be uncertain and imperfect. As it would be superfluous to say more on this subject, I shall, for the present, confine myself to the *cadmias*, and those ores alone which, when decomposed in a proper manner, and fully purified, yield those metals called zinc and cobalt.

### Of ZINC.

Ores that contain zinc are found in numerous varieties and of different forms. Sometimes they are combined with oxygen and the sulphuric acid; and sometimes there are found in them, besides zinc, various foreign component parts, such as argil and siliceous earth, a little iron, lead,  
and,

and, at times, also a small portion of copper. In blende the sulphur is combined with iron, and the particles of zinc are scattered through the mixture. The so called furnace calamine is obtained by the fusion of some kinds of lead ore when the particles of zinc are sublimated by strong heat to a cooler place of the furnace called the *zinc stool*, where they adhere in the form of a grey or yellowish stone. In preparing brass, and other operations of the like kind, the sublimated zinc calx is collected under the name of *white nicht*; but what adheres lower down, and becomes a hard mass, is called *grey tutia*; and this substance, as some sulphureous vapour seems to adhere to it the longer it lies exposed near the smelting houses, becomes, by the effects of the atmosphere, always more proper for use. Besides the above, we have zinc calx, zinc spar, tutanago ore, the last of which was first discovered in China; but I am convinced, by experiments, that a like ore, which is natural flowers of zinc, is found in Germany in the Thomas-stollen at Bleiberg. We have also zeolite-formed calamine, zinc blende, glittering blende, black blende, reddish brown, phosphorised, greenish-yellow, white, and yellow blende. Such kinds are found in England, Siberia, China, Sweden, Silesia, Saxony, &c.

In examining these substances various chemists have rendered great service to mineralogy, particularly Brand and Schwab, counsellors of the mines in Sweden; and these were followed by Justi, Pott, Henkel, and, above all, Margraaf, who employed great care and accuracy in fusing and examining them; but Bergmann, to whom science is so much indebted, has given most excellent models for the decomposition of these ores. Whether there be native zinc or not, has never yet been fully ascertained; and we must still remain in doubt until the account of its being found in the island of Naxos, in the Archipelago, be better confirmed. The zinc ore of Gosslar, that found in Cornwall, and a little of the Swedish, can be rendered useful and pro-

ductive. The zinc obtained from China, under the name of *tutanego*, is considered to be purer than the German, and therefore a small difference is observed in their specific gravities.

The properties of zinc separated from its ore, and purified, are, that it scarcely undergoes any variation in atmospheric air or in water; and that, by the addition of copper, in different proportions, you obtain brass, pinchbeck, prince's metal, Mannheim gold, &c. All acids deprive it of its inflammable matter, and dissolve it with effervescence. With the vitriolic acid it gives a crystalline salt, which is sulphat of zinc, or, as it is commonly called, white vitriol. That white vitriol which is obtained not in a crystalline form, but in white masses like refined sugar, contains often a mixture of foreign metallic particles, such as iron, copper, and lead; but it may be purified by adding to a solution of it pure zinc, by which the above metals will be precipitated: if the solution be then filtered, and exposed to crystallize, you will obtain pure white vitriol.

By the nitrous acid, zinc is dissolved with a strong effervescence and in great quantity producing crystals: if you pour alcohol over these and distil them, you will obtain very good edulcorated spirit of nitre. It dissolves also in the muriatic acid, and emits a strong offensive vapour; this clear solution saturated cannot be brought to shoot into crystals: if you reduce it by evaporation to a gelatinous mass, and place it in a retort over the fire, you obtain, in the same manner as when you distil zinc with sal-ammoniac and corrosive sublimate, butter of zinc of a somewhat thick consistence.

It is soluble also in aqua-regia, and by that acid gives a triple neutral salt, in the same manner as sal-ammoniac. It dissolves likewise in concentrated acetic acid, and shoots into crystals: the remaining acids, viz. of sparry fluor, arsenic, borax, sugar, tartar, forrel, citrons, ants, phosphorus, and fat, exercise an action over zinc also. The alkaline solvents do the same; and the process succeeds best with a concentrated

trated solution of the volatile, not caustic alkali, during which an effervescence is observed, and by which the zinc exhibits traces of an acid: the produce is crystals of a neutral salt.

Flowers of zinc, like zinc itself, are soluble in an acid; but with this difference, that no effervescence takes place. These flowers are produced during the fusion of zinc in an open crucible, when the heat is increased to above 370 degrees. The metal then inflames with a whitish-green flame of a dazzling brightness, which seems to diffuse over the faces of those present a death-like paleness; and the metal, by being deprived of its inflammable matter, (united to oxygen,) is converted into a tender calx, which, by the violence of the inflammation, is, on account of its lightness, carried upwards like wool or a cobweb. Zinc, calcined in this manner, is called the flowers of zinc, and also *philosophic wool*, not to mention other singular appellations of the alchemists. During this operation zinc exhibits some phenomena, such as the smell, the flame, &c. which are similar to those that occur during the combustion of phosphorus; and therefore people were led to suppose that the phosphoric acid was contained in zinc. By the above process the weight of this calx is increased a tenth part, and, as some have remarked, even more, and at the same time it becomes fixed. When exposed on coals to the blow-pipe, it becomes yellow, and on cooling resumes its whiteness, which is a proof that the flowers of zinc are genuine. It can be fused into a yellowish-brown glass, and, by adding the inflammable matter, can be reduced in close vessels.

In a close vessel, exposed to a violent heat, zinc goes over in a metallic form, and by these means acquires the property of creaking, when it breaks like tin. It can also be brought to such a state that it may be drawn out into thin plates, and be flatted between metal cylinders; some specimens of which, by M. Sage of Paris, and M. Kratz of Berlin, I have in my possession. Zinc may be combined with the



greater part of metals, but not with lead, iron, or bismuth; and it may be amalgamated with quicksilver. This amalgam of zinc is very proper for strengthening the power of an electric machine, and Higgins has given a prescription for preparing it. In the dry way it has the greatest affinity with copper, and produces with it a more or less yellow composition, which can be obtained by no other metal. In this respect, then, it is essentially different from all other metals, and becomes itself a very useful one, as it is used for brassy, pinchbeck, prince's metal, bronze, Manheim gold, and in fire-works, &c.

It is very remarkable, in regard to zinc, that neither sulphur nor liver of sulphur \* produces on it any effect; whereas gold, which sulphur cannot overcome, is dissolved by liver of sulphur.

On this occasion I cannot omit making mention of the celebrated alchemist of Respur, who believed, that when he alcalised zinc and rendered it caustic, and had obtained from it a purple-coloured mass, volatile in the open air, he had found out a menstruum, by which he could radically dissolve all metals. A paradoxical position, which was long adopted by the gold-making alchemists, but which has never been realised.

[To be concluded in next Number.]

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VI. *Description of an Assay-furnace, with an Apparatus for measuring the Degree of Heat employed. By Mr. DAVID MUSHET of the Clyde Iron Works. Communicated by the Author.*

**I**N my last paper I mentioned, that, in order to facilitate the operations of the assay-furnace, and to compare the various degrees of heat in which different experiments are

\* It has been ascertained that zinc and sulphur can be united; but the process is difficult, on account of the easy oxidation and volatility of the zinc. See *Mém. de Dijon*, 1783.

effected, I had constructed the pyrometer which I am now about to describe. It can in no point of view be considered as an universal instrument, as its scale will be entirely local, and vary according to the construction and exigencies of the furnace: it possesses, however, this advantage, that after a scale of comparison is formed betwixt it and Wedgewood's, in the manner described in the explanation, the assayer can at any time mark, with considerable accuracy, the degree at which an experiment is effected, and compare it with the degrees of that scale; and if the furnace and apparatus are kept in proper repair, the results will be consistent with former ones.

#### DESCRIPTION of the FURNACE.

AA (Plate V.) the pedestal of brick-work on which the furnace is reared. B, the ash-pit. C, a view of the central parts of the grate, with a knee two inches deep and four inches square, for the purpose of receiving a pedestal of fire-clay for supporting the crucible. DD, the section of an iron cylinder, which contains the brick-work, with flanges projecting inwards both at top and bottom: the upper flange contains two grooves for sliding the cover I, (made of cast iron;) and the under one projects so far as to form a support for the bars of the grate. EE, the lining of the furnace, composed of fire bricks. F, the fire-place, three feet deep, ten inches diameter at the grate, and diminishing to nine inches at the top. G, the flue or draught-hole, which communicates with the chimney. H, the chimney (the top broken off to make it come into the plate), which should never be less than 30 feet high, and nine inches square in the passage. K, an oblong rectangular plate, which projects from the top of the cylinder for the purpose of supporting the pyrometer. LL, an iron box with a square bar of steel, which, in expanding, acts upon the lever at the distance of one inch from the fulcrum.

The letters of the horizontal and vertical section refer to the same parts of the furnace.

DESCRIP-

## DESCRIPTION of the PYROMETER.

The principle upon which this instrument is constructed is the expansion of metal by heat. After several experiments with copper, iron, and steel, I was induced to give the preference to the latter. Copper was found to be too easily fused, and the scale by that means less extensive than was wished. Malleable iron, by being heated in this manner, frequently acquired permanent additional length, and passed into the state of semi-steel. This principle it derived from the contact of the surrounding charcoal, introduced for the purpose of preventing oxydation from taking place upon the surface of the bar. Highly cemented steel, when exposed in this manner to the greatest heat, acquired no sensible increase of length: a bar of polished steel was therefore adopted.

A corresponds with the plate of iron K in the drawing of the furnace, on which the pyrometer is supported. B an upright, on which is suspended the lever. CC the lever, ten inches long from the fulcrum to the extremity, which acts upon the scale, and one inch on the other end from the same point to a line drawn through the centre of the expanding bar. From this it is obvious, that if the short end of the lever be elevated half an inch by the expansion of the bar of steel, the other end will suffer a depression ten times as much, or equal to five inches. These I have divided into 50 degrees, (equal to each other on a tangent of the arch that forms the scale DD,) so that the most minute expansion in the bar will be visibly indicated. Should the ratio of ten to one be thought too small, the power of the lever can easily be increased to 13 or 20, and the scale thus greatly enlarged. When the pyrometer is at rest, the index points at  $0^{\circ}$ , and its other extremity rests lightly upon the sharp point of the steel bar. It is therefore requisite to make the lever nearly an exact balance, by forming its short end sufficiently weighty to overcome the great length of the other. The scale being carried the length of 50 degrees, allows the bar to expand

5-10ths. This, however, will not be the case, though exposed to a degree of heat approaching to fusion. EE are two supports for the scale, attached to the extremity of the plate by means of bolts. FF is a box of wrought iron which contains the bar of steel exactly fitted, with a small allowance for expanding in the thickness. This box is introduced into the lining of the furnace by means of square notches formed in the bricks about two inches from the contact of the fire. The bottom of the box rests upon the under-flange of the cylinder, and its other end rises through the building and iron-cover about two inches. When at first introduced into its place, the space which may remain betwixt the outside of the box and the building is carefully filled with fine charcoal dust, to prevent oxydation by the chance contact of atmospheric air. G is a polished bar of steel 3 feet 2 3-4th inches long and 1-4th of an inch square, the sharp extremity of which acts upon that part of the lever which, when at 0°, measures one inch from the fulcrum. HH, a small box or cover, which fits upon the top of the iron box by means of pins. This is always kept full of charcoal-dust, to prevent the approach of external air, and the transmission of heat from within.

This instrument may be used in conjunction with Mr. Wedgewood's scale. Any given substance may be melted, and the degree marked upon the scale: let this be compared with the degree of heat at which the same substance melts by Wedgewood's scale; then let the greatest degree of heat of the furnace be measured by one of Wedgewood's rolls, and compared with that pointed out by the index, the one difference divided by the other will give a scale of comparison.

It will hardly escape the notice of men of science, that circumstances may be so varied, by the modes of charging the furnace, as to endanger an erroneous result: but, if proper attention be paid, the assayer will soon understand the trim of his furnace so thoroughly as to be sure of always obtaining such an accurate indication of the heat as cannot

fail to be of essential service to him. This fact I can attest from experience.

If absolute precision be wanted, it may be obtained by employing three or more pyrometers, distributed at regular distances round the furnace, instead of using only one. The mean of the whole will be the true degree of heat in the furnace.

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VII. *Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE.

[Continued from page 190.]

CHAP. XVIII.

A. *Observations to be made on Volcanoes at the Time of an Eruption.*

1. **T**HE form, dimensions, and elevation of the crater.
2. The colour, elevation, and other sensible qualities of the flames and the smoke.
3. Phenomena which preceded the eruption, subterranean noise, earthquakes, extraordinary movements of the sea.
4. Phenomena which accompany the eruption; as thunder, lightning, positive or negative electricity, subterranean noise, earthquakes: scoriæ, ashes, and stones thrown up; to what height and distance.
5. Smell of the smoke. In general it indicates the sulphureous acid; but it may indicate also bitumen and coal.
6. Nature of the gases which escape during the eruption.
7. Velocity of the lava. Its degree of fluidity compared with the inclination of the ground over which it flows.
8. To measure, if possible, the degree of its heat when it issues from the volcano.
9. Whether the lava appears to be in a state of combustion, or only incandescence.

10. Whether it does not cool more slowly, and according to other laws, than that of the bodies heated or melted in our furnaces.

10. A. Can it be supposed that the matter thrown up by volcanoes was not inflamed, or even in a state of incandescence, in the bowels of the earth; and that it is only the contact of the air which gives it these qualities?

11. Whether the sudden cooling of lava in the air or in water divides it into prismatic columns, such as those of basaltes.

12. Whether it be true that scoria newly thrown up, and suddenly cooled by its rapid passage through the air, seems covered with a bituminous varnish.

13. And, in general, whether the mountain throws up bituminous matter or any thing that resembles the residuum of the combustion of coal, or whether it rather throws up pyrites or the residuum of their decomposition.

14. To ascertain by observations, and even by experiments, whether it may not be possible that pyrites or other ferruginous matters decomposed by water, undergo a fermentation, which, acting on grand masses, may disengage a sufficient heat to produce the effects of a volcano.

15. Or whether, as M. Romme thinks, the fire of volcanoes is kept up by matters accumulated by rivers and currents of the sea.

16. To search for means of ascertaining the depth of the focus of the volcano.

17. To examine whether, at the moment when an eruption begins to take place, there is any remarkable change in the tides, currents, springs, and the nearest spiracles and volcanoes.

18. Muddy eruptions: their height, bulk, nature of the water they contain; whether it be saline: nature of the earth and stones thrown up; whether it contains sea shells, of what kinds, and in what state. Watery eruptions: the same re-

searches: whether they hold in solution earths not usually soluble in water \*.

*B. Observations to be made at all Times on Volcanoes decidedly such.*

19. Nature of the countries and mountains between which they are found.

20. History of the volcano: its form, height, and extent in the most ancient times; its successive changes down to the present moment; its lateral mouths, and the epochs of their formation.

21. Chronology and enumeration of its different eruptions; description of them, and their most remarkable characters.

22. To descend, if possible, into the craters of extinguished volcanoes; to measure their depth; describe their form, the nature of their sides, their strata, and the concretions adhering to them, such as sulphur, salt, &c.

22. A. To observe the *fumaroles*, or jets of smoke, often acid, which arise; their temperature, their nature, and their effects on the lava with which they come in contact.

23. To examine the fissures; whether they contain metallic or stoney crystallisations, which may be considered as sublimed, and formed by the crystallisation of substances reduced to the state of smoke or vapour.

24. The nature of the streams of cooled lava; their extent and thickness.

25. Whether it be true that, in general, they are porous both at the upper and lower surfaces of the strata, and compact in the interior part.

26. To study the nature of the different currents placed above each other, in order to ascertain the difference that may have taken place in the focus of the volcano, and even in the source of its lava.

\* To observe those excavations from which considerable currents of air issue either periodically or constantly. C.

27. To examine, in general, in the lava, the nature of the earth and stones of which it has been formed.

27. A. To study the origin of the crystals found inclosed in the lava, as the white garnets or leucites in that of Vesuvius, in order to ascertain whether these crystals have been formed in the lava since the time of its fusion, or whether they pre-existed in the stones from which the lava was produced.

28. The nature and progress of the decomposition of the different kinds of lava, either by volcanic acids or meteors.

28. A. Whether there are any which have actually been in fusion, and yet have preserved all the external characters which the stone had before it was subjected to the action of the subterranean fires.

29. The origin of volcanic ashes, pozzolanas, tarras, tufas, &c.

30. The origin of pumice stones: whether they are granites or feld-spars, asbestos, phrenites, deodalites, or potter's clay more or less ferruginous, or, lastly, the remains of the decomposition of pit-coal.

30. A. Whether, as M. de Fichtel believes, the action of the fire of volcanoes may augment the fusibility of feldspar, and change it, in the same manner as quartz, into real zeolite.

31. Nature of the obsidians or volcanic glass: whether they be really glass, and the results of a complete fusion; or whether they are not rather stones of a vitreous appearance, and which have not been exposed to the action of a heat sufficiently strong to fuse them.

32. Whether there exist ancient kinds of lava, which, as related of those of Ischia, are susceptible of being heated by the moisture of rain and fogs, which would support the conjecture of No. 14.

*C. Observations to be made on Hills and Mountains which are doubted to have been really Volcanoes.*

33. The form, elevation, and other dimensions of the hill

or



or mountain, the volcanic origin of which may appear doubtful.

34. Situation of its strata. To ascend to the summit of those which are inclined; to examine whether they have not a crater, or vestiges of one.

35. To observe, above all, whether, in departing from the most elevated point, there are found strata diverging in all parts, and proceeding from that point as a centre.

36. To study the characters of the stones which have been exposed to the action of the fire, in order to distinguish them from other porous stones, such as glandulous stones or amygdaloides.

37. When these characters are discovered, to examine whether, in the neighbourhood of the doubtful mountain, there are found scattered stones which exhibit the same characters, and which seem to have proceeded from that mountain.

38. To observe whether there are found, in the neighbourhood of the doubtful mountain, any vestige of the remains of heat concealed in the bosom of the earth, as of thermal, or even acidulous waters. It is well known that these signs are equivocal, but their combination with others may throw some weight into the scale.

38. A. Whether there exist certain proofs of alternate deposits of lava or other volcanic productions, and of matters accumulated or deposited by the sea.

39. Among the stones changed by the fire, to discover those which may be considered as having been subjected to the action of one stratum of coal in deflagration, and which the celebrated Werner calls *pseudo-volcanic*, and to distinguish them from those which have been fused in a real volcano.

40. Basaltes: their forms in columns, in beds, round masses; their connections, the relation which the basaltes of these different forms observe with each other.

41. The nature of these basaltes: that of their texture, of the points which they contain, of the pores and empty

or full cells that may be observed in them; of their different accidents and decomposition.

41. A. The phenomena they exhibit in the fire, either exposed to, or sheltered from the action of the air. But before any arguments are drawn from these experiments, it will be necessary to resolve the question, Whether it be true that a stone may have been melted by subterranean fire, and yet none of its characters exhibit those indications of fusion which the fire of our furnaces would have given to the same stone.

42. Their connection, if there be any, with lava, fully ascertained as such: if it be true, for example, as M. Faujas affirms, that currents of lava are seen terminated by columns of basaltes.

43. The nature of the bases on which the basaltes rests: whether, as M. Werner says, any is found resting on wacke or hornstone, of an earthy and compact fracture, which itself reposes on sand or freestone.

44. Whether at other times basaltes is seen to repose on beds of coal (*bouille*) which present no indications of combustion.

45. In a word, to examine whether the soil which bears them, or the sides of the veins in which they are contained, present indications of the action of fire, or at least of having been exposed to the contact of an incandescent mass; or, on the contrary, whether there appear indications of deposits of a substance which had been in a state of aqueous fluidity.

46. Whether there are in the basaltes vestiges of organised marine bodies or others; and in what state these vestiges are found.

47. Whether there are observed, as M. Faujas says, basaltes which seems to have formed a passage for itself from top to bottom through masses of granite.

48. In doubtful cases of this kind it would be necessary, were it possible to be at the expence, to push a gallery under a rock of basaltes, to examine whether the columns descend  
below

below the soil which seems to carry them; and if they are found below the soil, to sink a vertical well to ascertain the truth of the systems which suppose them to have been raised from the interior parts of the earth through the upper strata.

[To be continued.]

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VIII. *Observations on the different Inducements to the Eating of Human Flesh.* By J. DE LOUREIRO \*.

THE first inducement which can lead men to this excess is extreme hunger; but however pardonable it may be under such circumstances, if the flesh used be that of dead bodies, it is highly detestable on account of the consequences. During a dreadful famine in India, which destroyed more than a hundred thousand persons, when the roads and streets were covered with dead bodies, because people had not sufficient strength to inter them, I saw several have the resolution to preserve their lives by this disgusting food; but some of them, though not many, found it so delicious that when the famine was at an end they retained such an irresistible propensity to human flesh that they lay in wait for the living in order to devour them. Besides others, there was a mountaineer who concealed himself in a forest near the highway, where he used to cast a rope, with a noose, over the heads of the passengers, whom he afterwards cut to pieces to gratify his unnatural appetite. He had killed many persons in this manner, but he was at length caught and executed. At the same time, and owing to the same cause, a woman used to go out for the express purpose of carrying away children who had strayed from their homes. She stopped up their nose

\* The author of this paper is an eminent Portuguese naturalist. A copy of it was given by the author from his own manuscript, never published, to Dr. G. H. Langsdorf, physician to Prince Christian of Waldeck at Lisbon, on the 5th of January 1798, who translated it into German, and sent it to Professor Voigt of Jena. See his *Magazin für den neuesten Zustand der Naturkunde*, Vol. I. part 3.

and mouth with clay that they might not call out for assistance, and by these means suffocated them. She confessed the fact on being taken, and some salted human flesh was found in her habitation. My servant having entered it, observed a girl of four or five years of age who had been suffocated in the above manner, and who was lying wrapped up, half dead, in a mat. By employing proper means she was however restored to life.

The reason of the second inducement to anthropophagy will now be readily comprehended. We read in different works, both ancient and modern, that many nations, in various parts of the world, have killed men, not on account of famine, but of the delicious taste of human flesh, which they not only fed upon but publicly sold.

The third inducement, that people eat their deceased relations by way of shewing them honour, seems to be as romantic as it is repugnant to nature; yet there are many authors, from Herodotus, the father of history, down to modern times, who assert that this practice has prevailed among various nations.

A fourth incitement to eat human flesh is hatred and revenge. There is a law in Cochinchina, that all rebels, when convicted of their crime, shall be executed, and that their flesh shall be devoured by the king's loyal subjects, and, in particular, by those who are nearest his person. At the time I resided in that country several executions of this kind took place. The men were beheaded, but the women were stabbed. After the execution the soldiers who guarded the palace flocked around the bodies, and each cutting off, with a pocket knife, a small piece, dipped it in the juice of an unripe lemon, and in that manner swallowed it. But as the size of the morsel is not determined by the law, and as most of the people have an aversion to such food, many suffer the bit of flesh to drop through their fingers and swallow only the lemon.

At the time when the Cochinese were at war against the  
- *Mois,*

*Moïs*, a people who inhabit the mountains to the west, and who often make incursions into their territories, the Co-chinese general marched with an army towards the mountains; but as he was not able to get at the enemy, on account of their inaccessible situation, he ordered two prisoners he had taken to be put to death, and their flesh to be devoured by his soldiers.

In the year 1777, being on board an English ship of war in Turon harbour, in order to return from Cochin-china to Europe, a party arrived there who had joined a powerful rebel named *Nbae*. This leader and his party had taken some of the king's confidential friends, and one in particular who had formerly done him a great deal of injury. The latter they put to death; and in order to gratify their revenge, they tore out his liver and ate it. The Cochin-chinese, in general, when violently incensed against any one, are accustomed to express a wish that they may be able to devour his liver or his flesh.

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IX. *Description of an improved Discharging Electrometer.*

*Read before the Royal Society of Copenhagen. By A. W. VON HAUCH, Marshal of the Court, &c. to his Danish Majesty\*.*

NO branch of natural philosophy can boast of having attracted so much attention as the doctrine of electricity; and indeed there are few which seem more worthy of investigation. When we consider the distinguished part which electricity apparently performs in the grand operations of nature; the astonishing, and, on the first view, so inexplicable effects produced by this power of nature so different from those of any other, and its secret and concealed mode of action, which the most acute observers have not hitherto been able to penetrate, it will not seem surprising that both

\* From the *Transactions of the Royal Society of Copenhagen.*

the learned and the unlearned should, with unabated zeal, have employed their attention on this phenomenon, as important to speculative philosophy as it is by its influence in society. Without this incessant attention our knowledge would not have made such rapid progress as it has done in the last forty years; and there might have been little difference between Otto von Guericke's balls of sulphur, or Haugen's glass globes, which were seventy years later, and the electric machine now in the Teylerian Museum at Haarlem. The former were scarcely sufficient to attract the lightest bodies, whereas the latter approaches near to nature in its strength, in its awful and wonderful effects; and seems to favour the possibility of the idea, that there are natural powers capable of impelling heavy bodies with prodigious force; and which, conducted by the hand of man, may, some centuries hence, banish the use of gunpowder, as the latter, a few centuries ago, banished bows and arrows.

Franklin conveyed electricity from the atmosphere, loaded a battery with it, and directed its mighty power with the same ease as that weak power excited by an electric machine. On account of the above-mentioned possibility of exhibiting the electric power in a certain degree and of a certain strength, it was found more and more necessary to have instruments proper for ascertaining these, and by which it might be determined with precision when and how a required effect could be produced.

Though these instruments have undergone many variations and improvements, and though there is an essential difference between Stephen Gray's or Du Fay's threads and the electrometers of Achard and Brooks \*, they are all to be considered rather as announcers of electricity than as accurate gauges or measures, as they are all incapable of shewing its intensity. Another instrument, hitherto equally imper-

\* A description of these Electrometers may be seen in Adams's and Cavallo's Treatises of Electricity, and in other works of the like kind.  
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fect, though no less important in electric experiments, is a discharging electrometer; for, as it is believed that the laws of electricity can be defined with mathematical certainty\*, it must be of importance to be able to employ, with the same certainty, the electric power which has been excited; and every instrument tending to promote this object, though still imperfect, must be of some utility, and be not unacceptable to those fond of electrical experiments. All the discharging electrometers hitherto known, perform their effect either by spontaneously discharging, as that of Lane, or as Henley's general discharger, &c. and in this case are affected by the greater or less conducting property of the air, which must necessarily be changed on each change of the atmosphere, and therefore must render the instrument very imperfect and incorrect; or the effect is produced by introducing a conducting body between two electric atmospheres, and by these means uniting them. But as this must depend on the greater or less dexterity of the person who performs the experiment to determine the proper moment for discharging, and as another electrometer is at the same time necessary, this method of discharging is as uncertain as the first.

I have endeavoured, therefore, to construct an instrument to supply this deficiency; and I hope it will not be found unworthy of attention. It is an electrometer which, though founded on the same principles as that of Brooks, that is, on comparing the effect of the repulsive power of electricity between two bodies of a given size with the known weight requisite to produce that effect, has, in my opinion, some improvements which are wanting in the other; for the state of the barometer has no influence upon this electrometer, as it has on that of Brooks; nor does friction, which is far from being unimportant, here take place. But as this in-

\* See Lord Stanhope's *Principles of Electricity*, 3d, 4th, and 5th parts; and Coulomb's description of an instrument by which it is proved that the effect of the electric matter is in the inverse ratio of the square of the distance.

strument is intended to be used as a discharging electrometer, and must be examined as such, no comparison can properly be made between it and any of the other electrometers hitherto employed.

Plate VI contains a representation of the electrometer, and the different parts of which it consists. OP is a board of dry mahogany, twelve inches in length and four in breadth, which serves as a stand for the instrument. In this board are fastened two massy glass pillars, M and N, which support the two brass capes or rings GG, with the two forks of tempered steel KK screwed into them. The two rings GG are well covered with varnish.

In the ring G is fastened a brass rod, which terminates in a ball E of the same metal, and an inch in diameter. The length of the rod and ball together is four inches and a half.

A very delicate beam, AB, the arms of which are of unequal length, moves on a sharp triangular axis (a knife edge) of well tempered steel on the fork K of the pillar M. It is seventeen inches in length, and so constructed that the short arm forms a third and the long one two-thirds of the whole beam. The short arm of brass furnished with the ball B, exactly of the same size as the ball E, is divided into forty-five parts equivalent to grains. The long arm A is of glass covered with copal varnish, and ends in an ivory ball A, into which is fitted an ivory hook R, destined to support the ivory scale H. In order to render the insulation more complete, this scale is suspended by three hairs.

A very delicate beam, CD, eleven inches in length, moves on an axis, like the former, on the pillar N, though not here shewn. This beam is proportioned in the same manner, one arm being a third and the other two-thirds of the whole length. The long arm of brass is furnished at the end with a ball D, and divided into thirty parts corresponding to grains. The short arm of glass terminates in a long roundish plate C, covered with copal varnish. The steel  
forks



forks are shewn by the sections of the two brass caps FF, as are also the two knife edges LL. By these caps the escape of the electric matter is partly prevented.

A brass ring Q, capable of being moved along the short arm of the upper beam AB, shews, by means of marks determined by trial and cut out on the beam, the number of grains which must be placed in the small scale to restore the equilibrium of the beam at each distance of the ring Q from the point of suspension.

On the long arm CD of the lower beam there is also a moveable ring S, which, like the ring Q, shews in grains, by its distance from the point of suspension, the power requisite to overcome the preponderance of LD in regard to LC.

The power necessary for this purpose will be found if the shell H, which weighs exactly fourteen grains, be suffered to sink down on the glass plate C, and the ring S be pushed forwards till both the arms of the beam are in equilibrium. The part of the beam on which the ring S has moved is divided into fourteen parts, so that o marks the place where the ring S must stand when the beam, in its free state, is in equilibrium; and 14 stands at the place where the ring S again restores a perfect equilibrium when the shell H is laid on the glass plate C. Each of these parts, which are divided into quarters, indicates a grain. The lower divisions of the scale will be found with more accuracy if quarters of a grain be put, in succession, into the shell H (after it has been laid on the plate C), and the ring S be moved between each quarter of a grain until the perfect equilibrium be restored. This place on the beam is then to be marked, and you may continue in this manner until the 30th part of a grain be given. Both scales, for the sake of distinctness, are divided only so low as quarters of a grain; though the instrument is so delicate, and must absolutely be so, that 1-20th of a grain is sufficient to destroy the equilibrium.

The two glass pillars M and N, together with the steel forks

forks affixed to them, are so fitted into the stand that both the beams lie parallel to each other as well as to the rod GE. In this position of the beams AB, the balls B and E are just in contact. The smallest glass pillar N is of such a height that the ball of the beam CD stands at the distance of exactly four lines from the ring G, and cannot move without touching the latter. The small shell H is suspended in such a manner that there is a distance of exactly two lines between it and the shell C. In each of the brass rings GG is a small hole, that the instrument may be connected with the two sides of an electric jar. I is a brass wire, with a hollow bit of ivory *a* destined to support the beam CD, which is necessarily preponderant at D, in order to prevent oscillation between the discharges to be examined by the instrument.

It may be readily comprehended that, when the beam AB has moved, A must pass over twice the space that B does; and that, in the beam CD, the case is the same in regard to C and D. If AB therefore be connected with the external side, and CD with the internal side of a battery, but in such a manner that the instrument is at a sufficient distance beyond the electric atmosphere; and if the battery be charged, the repulsive effect of the electric power will oblige the ball B to separate from the ball E; the shell H must therefore naturally sink down with double velocity, so that when the ball B rises a line, the shell H must sink two: when it reaches this depth it will touch the shell C, and the latter, by the power excited in it, will be obliged to sink, by which D must naturally again ascend in a double proportion to the sinking of C; so that when C has fallen two lines, D must have ascended four, and D that moment touches the ring by which the two sides of the battery are connected with each other, and discharges the battery.

But, as the attractive electric power between unlike atmospheres, under like circumstances, is at least as strong as its repulsive power between like atmospheres, it would thence follow that the electric power, instead of repelling the ball B  
from

from the ball E would rather attract D, and, by its contact with G, promote the discharging; by which the instrument would fail of its object, and be subjected to the temperature of the atmosphere like all other electrometers; and besides this, the electric power could no longer be determined by weight. To obviate this inconvenience, the instrument, in all electrical experiments, must be applied in such a manner that the power with which the ball D is attracted by AB may exceed in strength the power required to repel the ball B from the ball E. For this purpose the ring S must always be removed two divisions farther on CD, towards D, than the ring Q is shifted on AB towards B. If, for example, an electric force were required equal to eight grains, according to this electrometer, the ring Q must be removed to the place where 8 stands, and the ring S to the place marked 10. The repulsive power will then naturally repel the balls B and E before G is in a condition to attract the ball D, as a power of two grains would be necessary for this purpose, besides that of the eight already in action. The shell H, with its weight of fourteen grains, will easily overcome the preponderance of LD over LC, as it amounts only to ten grains, and therefore nothing exists that can impede the discharging.

When the ring S, according to the required power, is removed so far towards D that the shell H is not able by its weight to destroy the preponderance of LD in regard to LC, the active power of the shell H must be so far increased by the addition of weights that it can act, with a preponderance of four grains, on the plate C. If, for example, an electric power of fourteen grains be required, the ring S must be removed to 16, by which LD rests upon *a*, with a preponderance of sixteen grains in regard to LC. Now to make H act on the plate C with a preponderance of four grains, it must be increased to twenty grains, that is, six grains weight more must be added, as it weighs only fourteen; which six grains are again laid upon LB; and therefore the ring Q is shifted to 20, as the

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strength of the repulsive power is pointed out by fourteen grains.

If an electric power of twenty-five grains be required, the ring S must be removed to 27, and the weight of seventeen grains be put into the shell H in order to produce a preponderance of four grains in regard to S. These seventeen grains are added to the required power of twenty-five grains, and the ring Q is pushed to 42, &c. In this manner the repulsive power always acts before the attractive power can.

It may be readily perceived that the faults and inconveniences common to all the electrometers hitherto employed, and which have been already mentioned, cannot take place here; because the discharging is performed by immediate connection between the positive and negative electricity in the instrument itself, without any external means being employed.

One of the most essential advantages of this instrument is, the certainty with which the same result may be expected when the experiment is repeated. For the same degree of electric power, whatever be the temperature of the atmosphere, will always be necessary to commence the separation of the two balls B and E from each other, the quantity of coated glass and the distance of the ring Q from the axis L being the same.

Another no less important advantage of this instrument is, that in an experiment where the same electric power, often repeated, is necessary to ascertain the result with accuracy; such, for example, as the charging a battery through acids, water, &c.; the same degree of precaution is not necessary as is indispensibly so in any other electrometer, as the person who puts the machine in motion has nothing to do but to count how often the electrometer discharges itself; and the instrument may be inclosed in a glass case, or prevented in any other manner from external contact, or any other circumstances which might render the experiment uncertain.

I flatter myself that the simplicity of the construction of this instrument, the facility with which it may be made at a very small expence, and the certainty that two instruments, prepared according to the same scale, with a like quantity of coated glass, must exactly correspond with each other; but, above all, that the certainty and accuracy by which experiments may be made with it,\* and by these means be accurately described, are advantages which will not be found united in any of the electrometers hitherto invented.

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*X. Observations on the Tones produced by an Organ-pipe in different Kinds of Gas. By C. F. F. CHLADNI\*.*

AIR, it is well known, is the most common conductor of sound; but it can become a sonorous body also. The latter is the case in regard to a pipe, as the pipe itself does not emit sound, but the column of air included in it, and which, being separated from the rest of the atmosphere, is obliged, by blowing, to vibrate in such a manner that it contracts and expands longitudinally in various ways; and these vibrations are then conducted to a distance by the surrounding air. It is not necessary that I should here farther explain the different kinds of vibration of which the air in a pipe is susceptible. Those who are desirous of information on this subject may consult Daniel Bernoulli's papers in the Memoirs of the Academy of Paris for 1762; those of Lambert, in the Memoirs of the Academy of Berlin for 1775; and of Euler, in the Sixteenth Volume of the New Transactions of the Imperial Academy of Petersburg.

The conducting of sound through the air, and the vibrations of air in a pipe, depend on the same laws. This will readily appear from the following observation, besides others, that the velocity of the vibrations, under like circumstances,

\* From *Feigl's Magazin für den neuesten Zustand der Naturkunde*, Vol. I. part 3.

depends merely on the length of the pipe, and not on its diameter; so that the velocity is not changed when the pipe is indefinitely enlarged, or, what is the same thing, when it is totally removed, so as to afford free access to the air on all sides. Sound therefore is diffused through a certain space of air, in the same time in which a column of air inclosed in a pipe makes one vibration; a proposition which has been proved in the before-mentioned papers of Euler, Bernoulli, and Lambert, and also by Count Giordano Riccati in his Treatise on Elastic Fibres or Strings, and which is confirmed by experience. Hence it follows, that the number of the vibrations made by the air in a pipe may be found, if the real velocity with which sound is conducted through the air be divided by the length of the column of air contained in the pipe.

The labours undertaken by Newton, Euler, Daniel Bernoulli, Lambert, Giordano Riccati, and others, to determine, from general mechanical principles, the velocity with which sound is conducted, have given no other results than those taught by experience. By all these theoretic researches the space through which sound passes in the air, or, in general, in any expansible fluid substance, was found to be  $= \sqrt{\frac{2ga}{b}}$ ; where  $g$  is the space through which a heavy body falls in a second, or in any given time;  $a$  the elasticity of the expansible fluid, which is assumed equal to the pressure it sustains from the atmosphere; and  $b$  the density of the expansible fluid:  $a$  may be also the height of the barometer, if the density of the mercury be considered as 1. Theory gives, therefore, about 900 Parisian feet as the distance to which sound is transmitted through the air in the course of a second; whereas this space has been found, by experience, to be equal to about 1038. No one has ever yet assigned a sufficient reason for this difference. The most common conjecture is, that it must be owing to a mixture of various foreign particles; but this, by those acquainted with

with the nature of atmospheric air and the different kinds of gases, as ascertained by chemical experiments, can hardly be admitted, and is contradicted by this circumstance: that, according to every observation, the state of the air, whether moist or dry, cloudy or rainy, does not alter, or at least in a sensible manner, the velocity with which sound is conducted. Various other conjectures seem to be equally inconsistent with nature. From the present experiments it follows, in my opinion, that the velocity of the vibrations of an expansible fluid substance cannot be determined by the mechanical principles hitherto admitted alone; but that it depends, besides these, upon other properties.

Were the before-mentioned data sufficient to determine the vibrations of an expansible fluid, the tone which a pipe can emit, both in the air and in different kinds of gases, under like circumstances, would be inversely as the square root of the specific gravity of the expansible fluids. The result given by the present experiments is, however, different. As I was not furnished with the apparatus proper for the purpose, I requested, during my residence at Vienna, professor Jacquin junior, who has a great zeal for the progress of science, to undertake the experiments; and he was so good as to comply with my wishes.

The apparatus consisted of an open tin organ-pipe, in which the length of the vibrating column of air from the aperture where the inflated air issues to the end was about six inches, having its upper end inserted in the neck of a bell-glass, that could be closely shut by means of a cock. On immersing the bell in water, the pipe was at the same time filled with it, to guard against all mixture of atmospheric air. A bladder, furnished also with a cock, was screwed upon the neck of the bell, after having been compressed as much as possible, and emptied of air by applying the mouth to it. The bell and the bladder were then filled with such a quantity of the air to be examined, that the water, in which the bell was immersed, stood at an equal

height both in the inside and outside; and the pressure sustained by the bell was equal, therefore, to the pressure of the atmosphere. The pipe was blown by compressing the bladder; but the greatest caution was necessary to prevent the pipe from emitting, instead of its natural tone, any of its higher tones, which in an open pipe, as is well known, are as the natural series of the numbers, that is, in arithmetical progression. A weak and uniform pressure was therefore necessary, but which could be repeated at pleasure; because, when the pressure was omitted, the superfluous gas returned back into the bladder. The temperature, which certainly contributes in some degree to vary the tone of a wind instrument, in regard to all the different kinds of gas, was always the same; that is, the degree which is usual on a somewhat cool morning in spring. To enable me to judge with more accuracy of the tone, I had tuned two strings to an unison of that tone produced in common air: the experiments were made with the utmost accuracy, so that I have reason to think there was no room left for the smallest deception.

The bell and the pipe being first filled with common air, the tone was exactly the same as that of a pipe blown when it is perfectly free; but much weaker, as must have been expected, because the vibrations of the air inclosed in the bell were propagated, and could be communicated to the surrounding atmosphere only through the sides of the bell and through the water. But though the sound, for the same reason, was somewhat weak in the other experiments, they could, however, be heard very distinctly.

In oxygen gas from manganese the sound was half a tone or nearly a whole tone lower than in common air. This nearly agrees with theory; according to which the difference must amount to almost half a tone, if the gravity of atmospheric air be to that of oxygen gas as 1 to 1.103, and the tone inversely as the square root of the gravity.

The most striking deviation from theory was exhibited by azotic gas. It might have been expected that the sound of  
it



it would have been a little higher than that of common air, because it is somewhat lighter, and because its gravity is to that of atmospheric air as 0.985 to 1; but it was half a tone lower. Three kinds of azotic gas were tried; one produced by means of liver of sulphur, another by a mixture of iron and sulphur, and the third from common air by means of nitrous gas.

In all the three a taper was extinguished in a moment, and they all gave the same tone. Should it be here suspected that the azotic gas disengaged from atmospheric air by sulphur and iron, might have had a mixture of hydrogen gas, the tone in that case must have been raised rather than lowered by the latter on account of its lightness. We may therefore consider it as certain, that the vibrations of azotic gas, let it be prepared in whatever manner it may, are much slower than the vibrations of atmospheric air; and that the difference amounts to about half a tone. It is remarkable that azotic gas in particular should exhibit, in regard to its vibrations, such a variation from the common theory, as, according to late experiments, it differs so much from other kinds of gases in regard to its expansibility at different degrees of heat. It would be well worth the trouble to repeat these experiments, respecting the vibrations of azotic gas, at different high and low degrees of temperature. It ought also to be examined with more accuracy, whether Marriot's law, that at the same temperature the density of an expansible fluid increases and decreases in proportion to its pressure, may not admit of some exception in regard to azotic gas; as this inquiry would, in all probability, enable us to explain the variation of its vibrations from the common theory.

A very remarkable phenomenon was exhibited by a mixture of azotic and oxygen gas. It might have been supposed, that azotic gas, being a lighter substance, would have occasioned a higher tone than atmospheric air; and oxygen

gas, as a heavier substance, a lower tone; and that a mixture of these two would have given a mean tone between both. Experience, however, shews that each of these two expandible fluids, as I have already said, gives a higher tone than atmospheric air; and that a mixture of them gives a tone higher than either of these can give alone, and perfectly similar to the tone of atmospheric air. The quantity of oxygen gas mixed with the azotic gas might, according to appearance, be at first about a fourth; afterwards a third, or somewhat more; which however made no considerable variation in the tone. I am of opinion, therefore, that the unknown cause which occasions a mixture of these two substances to vibrate quicker than each of them taken singly, may also occasion sound to be conducted with greater velocity than it ought, according to common theory, through atmospheric air, which has the same component parts as the above mixture. This greater velocity seems to imply rather a chemical than a merely mechanical mixture of these fluids. But this is contradicted, besides other observations, by one in particular of that acute and diligent philosopher Professor Remigius Dottler of Vienna, who suffered common air to stand above a year untouched in a glass tube five feet in length and one and a half in diameter, which was well stopped both at top and bottom, and at the end of that time the component parts of the air were in some measure separated from each other according to their specific gravity; so that a lighted taper was extinguished in the lighter azot found at the top, while another burnt in the heavy oxygen gas at the bottom with more strength than in atmospheric air.

Hydrogen gas gave a far higher tone than atmospheric air; with that extricated by iron and the sulphuric acid, the difference was about an octave; with that by zinc and the muriatic acid, it was nearly an octave and a whole tone; by that from the steam of water conducted through a tube of ignited iron, it was somewhat above an octave and a small third.

third. This difference, however, is not so great as might have been expected from so light a gas, the gravity of which is to that of common air, when the gas is perfectly pure, as 0.084 to 1. Had the tones, therefore, been inversely as the square roots of the gravity, the tone with hydrogen gas from iron and the sulphuric acid, allowing it to have been only six or seven times lighter than atmospheric air, must have been about an octave and a large third higher; and by the lighter hydrogen gas, about an octave and a small seventh higher. By mixing atmospheric air with hydrogen gas, the tone, as might readily be expected, was lowered; but it is to be remarked, that as long as these two fluids were not uniformly mixed by filling and compressing the bladder, a discordant noise only was heard, and not a distinct sound, as the vibrations could not be isochronous, which forms the only essential difference between a distinct sound and such a discordant noise. The same thing was observed in regard to the before-mentioned mixture of azotic and oxygen gas.

The tone of carbonic acid gas from chalk and the sulphuric acid was almost a large third lower than the tone of atmospheric air; which agrees pretty well with theory, since the gravity of these fluids is as 1.5 to 1.

Nitrous gas from nitrous acid and copper was not very favourable to sound; and it required a strong pressure of the bladder and a great deal of caution, because, instead of the wished-for low tone, one of the higher tones was produced. The lowest tone, obtained with considerable difficulty, was about half a tone lower than in atmospheric air; which agrees also pretty well with theory, since this gas is heavier, and the gravities are as 1.195 to 1: the tone was also almost like that in azotic gas, notwithstanding the considerable difference in the gravities of these two fluids.

As to the velocity with which the sound of another elastic body would be conducted through these gases, could a sufficient extent of them be procured to make the observation, it follows, from what has been said in the beginning of this paper,

paper, that with equal pressure they would be in the ratio of the tones above mentioned.

The present experiments are very different from those of Priestley and Perolle on sound in different kinds of gases. The experiments of these two philosophers had relation only to the intensity with which the vibrations of another elastic body (of a bell struck by a hammer) are conducted through these gases. Perolle contradicts Priestley's assertion, that the power of conducting is as the densities; but to this rule Priestley himself makes an exception in regard to oxygen gas, which appears to be a stronger conductor: azotic gas was examined by neither of these philosophers. In hydrogen gas they both found the conducting power very weak, which is no doubt owing to its little density. In oxygen gas they found the sound somewhat stronger than in common air; in the nitrous gas Perolle found it also somewhat stronger. In carbonic acid gas Priestley found the sound stronger; but Perolle, weaker, duller, and somewhat lower than in common air: which last circumstance I consider as agreeable to truth, because the vibrations of a sounding body must be more retarded the denser the surrounding fluid is, or according to its greater pressure on that body. For this reason the vibrations of a body vibrating in our atmospheric air must be a little slower than they would be in a vacuum; as experience teaches that the sound of a bell becomes lower the more it is filled with water, or the deeper it is immersed in that fluid; so that, when it is struck at a considerable depth, it no longer emits a distinct sound, but rather a kind of discordant noise.

XI. *Letter from E. PEROLLE of the Academy of Turin, formerly Professor of Anatomy and the Practice of Medicine at Toulouse, to J. C. DE LA METHERIE, on the Acoustic Experiments of CHLADNI* \*.

I READ in your Journal of Messidor, 6th year, and in the *Bulletin des Sciences*, published by the Philomatic Society of Pluviose the same year, a short account of the experiments made by Chladni and Jacquin at Vienna, with a view to determine the sonorous properties of various gaseous substances. By causing a small tin pipe, brought into contact with a cock in the neck of a bell glass, to be blown by gas contained in a bladder applied to the external aperture of the cock, these philosophers observed, that the sound was a semitone lower with azotic and oxygen gas than with atmospheric air; a third lower with carbonic acid gas; and nearly the same with nitrous gas: but, with oxygen gas, from nine to eleven tones higher than with the air that surrounds us. A mixture of azote and oxygen, in the same proportions as in atmospheric air, gave the same tone as the latter; but when the mixture of these gases was not uniform, the sounds were totally discordant. The singularity of these results induced me to examine the experiments with attention.

Priestley †, several years ago, published some observations on the same subject; but he had made use of a metallic body rendered sonorous by percussion, after he had fixed it in a glass jar, which he filled successively with different kinds of gas. The æriform substances which he employed for his experiments appeared to him to propagate sounds in proportion to their density: he remarked, that in hydrogen gas the sound seemed like that produced in a vacuum or air highly rarefied. Is it to be supposed that such a philosopher as Priestley would have failed to discover the alteration of tones produced in the va-

\* From the *Journal de Physique*, an. 7.

† See *Observations and Experiments on different Branches of Philosophy*, Part III. p. 355.—Priestley made no experiments with nitrous gas.

rious aëriform substances? His ear would certainly have distinguished the falling of a third in the carbonic acid and nitrous gases; and he must, no doubt, have been struck with the prodigious rise occasioned by the hydrogen.

At the time Priestley made his experiments I was engaged in some of the same kind, the results of which were published in the Memoirs of the Academy of Sciences of Turin for the years 1786 and 1787. In my paper it may be seen that I successively filled a bottle, and inverted it in a pneumatocchemical preparation of various aëriform substances; and in these atmospheres I rung a small bell, and made a repeating-watch strike. As the sounds reached my ear, I paid attention to the variations they exhibited in regard to the tone, its intensity, and the vibration. To assist my ear I made use of a violin. Some idea may be formed of the result of my labours, by casting an eye over the first table of my memoir, of which the following is a copy:—

<i>Nature of the Gases examined.</i>	<i>Tone of the Sounds in different Airs.</i>	<i>Nature or Species of the Sound.</i>	<i>Distance at which they may be heard.</i>
1. Atmospheric air serving for a point of comparison.			56 feet 6 inches.
2. Fixed air, drawn from chalk by diluted nitrous acid.	Alike, or a little lower than in the preceding experiment.	Considerably duller.	48 feet 5 inches.
3. Vital air extracted from red precipitate.	Seemed a little sharper than in common air.	Clearer than in atmospheric air.	63 feet.
4. Nitrous air produced, by a nitrous solution of tin.	Nearly like the former.	Ditto.	Ditto.
5. Inflammable air produced by the action of diluted vitriolic acid on steel filings.	Not very distinct: it seemed rather a weak noise than a proper tone.	Had no harmony, no strength; and seemed to die away at	11 feet.

Chladni's experiments, therefore, seem to contradict those made by Priestley and myself. To reconcile them, it will no doubt be said that Chladni and Jacquin employed a wind-instrument, and that my experiments and those of Priestley were made with metallic bodies rendered sonorous by percussion. But whence does it happen that those fluids, some of which lower the sound of a pipe one-third, while another makes the sound of the same pipe from nine to eleven tones higher, have not power to alter the tones of a metallic body in any sensible degree? I shall here offer a few remarks which seem to arise from these general observations.

In a mixture of oxygen and azote, in the same proportions as in the atmospheric air, sound is the same, according to Chladni and Jacquin, as in the latter medium; but they add, if the mixture of these two gases is not complete, the sound is quite discordant. What! do oxygen and azote afford each of them the same sound? and does an incomplete mixture of them produce a discordant sound? It will no doubt be replied, that azote and oxygen do not give the same tone as atmospheric air; but, in theatres, ball-rooms, concert-rooms, &c. where a great number of spectators are assembled, and where there is a sufficient quantity of carbonic acid, which does not combine with the air of the atmosphere, has it ever been observed that wind instruments were discordant? If an incomplete mixture of atmospheric air with gas, which lowers the sound one third, does not render the sounds discordant, how can we persuade ourselves that a mixture of two gases, which cause a falling of only half a tone, should occasion a sound altogether discordant, merely because the portions of the gases are completely mixed, while the admixture of some other particles is much less complete?

The above authors inform us also, that in hydrogen gas the sound rises nine or eleven tones. Here there can be no medium. Either the sound produced in the hydrogen is sharper by nine tones, and in that case the elevation ought

not to be carried to eleven; or the sound is sharper by eleven tones in the hydrogen than in atmospheric air, and then it is wrong to say that it rises only nine tones.

This want of correctness and precision in determining the tone; this great latitude allowed to the hydrogen, of being able to raise the sound nine or eleven tones; does it not prove an indecision, an uncertainty on the part of these philosophers, little calculated to procure confidence to their experiments?

Let it not, however, be imagined, that I wish to contest the reality of their discoveries. Not having repeated the experiments of these authors, I can have no such intention. I have only endeavoured to give an account of those doubts which remained on my mind after I had taken the subject into consideration, and to engage the philosophers to remove the uncertainty by repeating the experiments.

One of these authors, Chladni, has made an observation which seems entirely his own. He observed, that when a plate of glass is agitated by means of a bow, if some dust is strewed over the glass, the former will appear to have arranged itself symmetrically, after the plate ceases to emit sound. Under the like circumstances the figures are always the same.

It is not at all surprising, that an elastic body, when put in motion by the same means, should constantly experience effects of the same kind. The light body placed on the surface of the glass with which the experiment is made, only confirms what we were already taught by reason. But before it be concluded that these motions produce sound, or tend to determine the tone, philosophers are invited to read my Letter to De la Metherie *On the Total Vibrations of Sonorous Bodies*, published in the *Journal de Physique* for December 1785. This letter, the sense of which is altered by some typographical errors\*, contains facts a little too precise

\* P. 424, at the end of the first line, add *adjutez*; same page, at the beginning of the 11th line, for *son* read *ton*; next line, for *anneau* read *arceau*.



perhaps, but which do not appear to me the less to merit the attention of the learned.

Philosophers, in my opinion, will find some curious observations on this subject also in my *Inquiries into the Propagation of Sound in different Solid as well as Fluid Mediums*; which will soon appear.

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XII. *On a Submarine Forest on the East Coast of England.*

By JOSEPH CORREA DE SERRA, LL. D. F. R. S. and A. S.\*

IN Geology, more perhaps than in any other branch of Natural History, there exists a necessity of strictly separating the facts observed from the ideas which, in order to explain them, may occur to the mind of the observer. In the present state of the science, every well ascertained fact increases our still narrow stock of real knowledge; when on the contrary, the reasonings we are enabled to make are at best but ingenious guesses, which too often bias and mislead the judgement. I shall, therefore, endeavour in this paper to give, first, a mere description of the object unmixed with any systematical ideas, and shall afterwards offer such conjectures on its causes as seem to me to be fairly grounded on observation.

It was a common report in Lincolnshire, that a large extent of islets of moor situated along its coast, and visible only in the lowest ebbs of the year, was chiefly composed of decayed trees. These islets are marked in Mitchell's chart of that coast by the name of *clay butts*; and the village of Huttoft, opposite to which they principally lie, seems to have derived its name from them. In the month of September 1796 I went to Sutton, on the coast of Lincolnshire, in the company of the Right Hon. the President of the Royal Society, in order to examine their nature and extent. The

\* From the Philosophical Transactions, 1799.

19th of the month, being the first day after the equinoctial full moon, when the lowest ebbs were to be expected, we went in a boat about half past twelve at noon, and soon set foot upon one of the largest islands then appearing. Its exposed surface was about thirty yards long, and twenty-five wide, when the tide was at the lowest. A great number of smaller islets were visible around us, chiefly to the eastward and southward; and the fishermen, whose authority in this point is very competent, say, that similar moors are to be found along the whole coast, from Skegness to Grimsby, particularly off Addelthorpe and Mablethorpe. The channels dividing the islets were, at the time we saw them, wide, and of various depths; the islands themselves ranging generally from east to west in their largest dimensions.

We visited them again in the ebbs of the 20th and 21st; and though it did not generally ebb so far as we expected, we could notwithstanding ascertain that they consisted almost entirely of roots, trunks, branches and leaves of trees and shrubs, intermixed with some leaves of aquatic plants. The remains of some of these trees were still standing on their roots, while the trunks of the great part lay scattered on the ground in every possible direction. The barks of trees and roots appeared generally as fresh as when they were growing; in that of the branches particularly, of which a great quantity was found, even the thin silver membranes of the outer skin were discernible. The timber of all kinds, on the contrary, was decomposed, and soft in the greatest part of the trees: in some, however, it was firm, especially in the roots. The people of the country have often found among them very sound pieces of timber, fit to be employed for several economical purposes.

The sorts of wood which are still distinguishable, are, birch, fir, and oak. Other woods evidently exist in these islets, of some of which we found the leaves in the soil; but our present knowledge of the comparative anatomy of timber is not so far advanced as to afford us the means of pronouncing  
with

with confidence respecting their species. In general the trunks, branches, and roots of the decayed trees were considerably flattened; which is a phenomenon observed in the *furtaarbrand*, or fossil wood of Iceland, and which Scheuchzer remarked also in the fossil wood found in the neighbourhood of the lake of Thun in Switzerland.

The soil to which the trees are affixed, and in which they grew, is a soft greasy *clay*; but for many inches above its surface, the soil is entirely composed of rotten leaves scarcely distinguishable to the eye, many of which may be separated by putting the soil in water, and dexterously and patiently using a spatula or blunt knife. By this method I obtained some perfect leaves of *Ilex aquifolium*, which are now in the herbarium of the Right Honourable Sir Joseph Banks; and some other leaves, which, though less perfect, seem to belong to some species of willow. In this stratum of rotten leaves we could also distinguish some roots of *Arundo phragmites*.

These islets, according to the most accurate information, extend at least twelve miles in length, and about a mile in breadth, opposite to Sutton shore. The water without them, towards the sea, generally deepens suddenly, so as to form a steep bank. The channels between the several islets, when the islets are dry, in the lowest ebbs of the year are from four to twelve feet deep: their bottoms are clay or sand, and their direction is generally from east to west.

A well, dug at Sutton by Joshua Searby, shows that a moor of the same nature is found under ground in that part of the country at the depth of sixteen feet, consequently very nearly on the same level with that which constitutes the islets. The disposition of the strata was found to be nearly as follows:—Clay, 16 feet—Moor, similar to that of the islets, 3 to 4 ditto—Soft moor, like the scowerings of a ditch bottom, mixed with shells and silt, 20 feet—Marly clay, 1 foot—Chalky rock, from 1 to 2 feet—Clay, 3 1 yards—Gravel and water; the water has a chalybeate taste.

In order to ascertain the course of this subterraneous stratum of decayed vegetables, Sir Joseph Banks directed a boring to be made in the fields belonging to the Royal Society in the parish of Mablethorpe. Moor of a similar nature to that of Searby's well, and the islets, was found, very nearly on the same level, about four feet thick, and under a soft clay.

The whole appearance of the rotten vegetables, we observed, perfectly resembles, according to the remark of Sir Joseph Banks, the moor which, in Blankeney Fen and in other parts of the East Fen in Lincolnshire, is thrown up in the making of banks; barks, like those of the birch-tree, being there also abundantly found. The moor extends over all the Lincolnshire fens, and has been traced as far as Peterborough, more than sixty miles to the south of Sutton. On the north side, the moory islets, according to the fishermen, extend as far as Grimsby, situated on the south side the Humber: and it is a remarkable circumstance, that in the large tracts of low land which lie on the south banks of that river, a little above its mouth, there is a subterraneous stratum of decayed trees and shrubs exactly like those we observed at Sutton; particularly at Axolme isle, a tract of ten miles in length by five in breadth; and at Hatfield Chace, which comprehends one hundred and eighty thousand acres. Dugdale\* had long ago made this observation in the first of these places; and De la Pryme† in the second. The roots are there, likewise, standing in the places where they grew: the trunks lie prostrate. The woods are of the same species as at Sutton. Roots of aquatic plants and reeds are likewise mixed with them; and they are covered by a stratum of some yards of soil, the thickness of which, though not ascertained with exactness by the above-mentioned observers, we may easily conceive to correspond with what covers the stratum of decayed wood at Sutton, by the

\* History of Embanking and Draining, chap. xxvii.

† Philosophical Transactions, vol. xxii. p. 980.

circumstances of the roots being (according to Mr. Richardson's observations \*) only visible when the water is low, where a channel was cut, which has left them uncovered.

Little doubt can be entertained of the moory islets of Sutton being a part of this extensive and subterraneous stratum, which, by some inroad of the sea, has there been stripped of its covering of soil. The identity of the levels; that of the species of trees; the roots of these affixed, in both, to the soil where they grew; and, above all, the flattened shape of the trunks, branches, and roots found in the islets (which can only be accounted for by the heavy pressure of a superinduced stratum), are sufficient reasons for this opinion.

Such a wide-spread assemblage of vegetable ruins, lying almost in the same level, and that level generally under the common mark of low-water, must naturally strike the observer, and give birth to the following questions:

1. What is the epoch of this destruction?
2. By what agency was it effected?

In answer to these questions, I will venture to submit the following reflections:

The fossil remains of vegetables hitherto dug up in so many parts of the globe, are, on a close inspection, found to belong to two different states of our planet. The parts of vegetation, and their impressions, found in mountains of a cotaceous, schistous, or even sometimes of a calcareous nature, are chiefly of plants now existing between the tropics, which could neither have grown in the latitudes in which they are dug up, nor have been carried and deposited there by any of the acting forces under the present constitution of nature. The formation, indeed, of the very mountains in which they are buried, and the nature and disposition of the materials which compose them, are such as we cannot account for by any actions and re-actions which in the actual state of things take place on the surface of the earth.

\* Philosophical Transactions, vol. xix. p. 528.

We must necessarily recur to that period in the history of our planet, when the surface of the ocean was at least so much above its present level as to cover even the summits of those secondary mountains which contain the remains of tropical plants. The changes which these vegetables have suffered in their substance is almost total; they commonly retain only the external configuration of what they were. Such is the state in which they are found in England by Llwyd; in France by Jussieu; and in the Netherlands by Burtin; not to mention instances in more distant countries. Some of the impressions or remains of plants found in soils of this nature, which were, by the more ancient and enlightened oryctologists, supposed to belong to plants actually growing in temperate and cold climates, seem, on accurate investigation, to have been part of exotic vegetables. In fact, whether we suppose them to have grown near the spot where they are found, or to have been carried thither from different parts by the force of an impelling flood, it is equally difficult to conceive how organized beings, which, in order to live, require such a vast difference in temperature and in seasons, could live on the same spot, or how their remains could (from climates so widely distant) be brought together in the same place by one common dislocating cause. To this ancient order of fossil vegetables belong whatever retains a vegetable shape, found in or near coal mines, and (to judge from the places where they have been found) the greater part of the agatized woods. But from the species and present state of the trees, which are the subject of this memoir, and from the situation and nature of the soil in which they are found, it seems very clear that they do not belong to the primeval order of vegetable ruins.

The second order of fossil vegetables, comprehends those which are found in the strata of clay or sand; materials which are the result of slow depositions of the sea and of rivers, agents still at work under the present constitution of

our planet. These vegetable remains are found in such flat countries as may be considered to be of a new formation. The vegetable organization still subsists, at least in part; and their vegetable substance has suffered a change only in colour, smell, or consistence; alterations which are produced by the development of their oily and bituminous parts, or by their natural progress towards rottenness. Such are the fossil vegetables found in Cornwall by Borlase; in Essex by Derham; in Yorkshire by De la Pryme and Richardson; and in foreign countries by other naturalists. These vegetables are found at different depths, some of them much below the present level of the sea, but in clayey or sandy strata (evidently belonging to modern formation); and have no doubt been carried from their original place, and deposited there by the force of great rivers or currents, as it has been observed with respect to the Mississippi\*. In many instances, however, these trees and shrubs are found standing on their roots, and generally in low or marshy places above, or very little below, the level of the sea.

To this last description of fossil vegetables the decayed trees here described certainly belong. They have not been transported by currents or rivers; but, though standing in their native soil, we cannot suppose the level in which they are found to be the same as that in which they grew. It would be impossible for any of these trees or shrubs to vegetate so near the sea, and below the common level of its water; the waves would cover such tracts of land, and hinder any vegetation. We cannot conceive that the surface of the ocean has ever been lower than it now is; on the contrary, we are led, by numberless phenomena, to believe that the level of the water in our globe is now below what it was in former periods: we must therefore conclude, that the forest here described grew in a level high enough to permit its vegetation; and that the force (whatever it was)

\* Le Coudriniere sur les Dépôts du Mississippi, Journal de Physique, vol. xxi. p. 230.

which destroyed it, lowered the level of the ground where it stood.

There is a force of subsidence (particularly in soft ground), which, being a natural consequence of gravity slowly though perpetually operating, has its action sometimes quickened and rendered sudden by extraneous causes, for instance by earthquakes. The slow effects of this force of subsidence have been accurately remarked in many places: examples also of its sudden action are recorded in almost every history of great earthquakes. The shores of Alexandria, according to Dolomieu's observations, are a foot lower than they were in the time of the Ptolemies. Donati, in his *Natural History of the Adriatic*, has remarked, seemingly with great accuracy, the effects of this subsidence at Venice; at Pola in Istria; at Liss, Bua, Zara, and Dielo, on the coast of Dalmatia. In England, Borlase has given, in the *Philosophical Transactions*\*, a curious observation of a subsidence, of at least sixteen feet, in the ground between Sampson and Trefcaw islands in Scilly. The soft and low grounds between the towns of Thorne and Gowle in Yorkshire, a space of many miles, has so much subsided in latter times, that some old men of Thorne affirmed, "that whereas they could before see little of the steeples (of Gowle), they now see the church-yard wall †." The instances of similar subsidence, which might be mentioned, are innumerable.

The force of subsidence, suddenly acting by means of some earthquake, seems to me the most probable cause to which the usual submarine situation of the forest we are speaking of may be ascribed. It affords a simple, easy explanation of the matter; its probability is supported by numberless instances of similar events; and it is not liable to the strong objections which exist against the hypothesis of the alternate depression and elevation of the level of the ocean; an opinion which, to be credible, requires the support of a great num-

\* Vol. XLVIII. p. 62.

† Gough's Camden.



ber of proofs less equivocal than those which have hitherto been urged in its favour, even by the genius of a Lavoisier\*.

The stratum of soil, sixteen feet thick, placed above the decayed trees, seems to remove the epoch of their sinking and destruction, far beyond the reach of any historical knowledge. In Cæsar's time, the level of the North Sea appears to have been the same as in our days. He mentions the separation of the Wahal branch of the Rhine, and its junction to the Meuse; noticing the then existing distance from that junction to the sea, which agrees, according to D'Anville's inquiries†, with the actual distance. Some of the Roman roads, constructed, according to the order of Augustus, under Agrippa's administration, leading to the maritime town of Belgium, still exist, and reach the present shore‡. The description which Roman authors have left us, of the coasts, ports, and mouth of rivers on both sides of the north sea, agree in general with their present state; except in the places ravaged by the inroads of this sea, more apt, from its force, to destroy the surrounding countries than to increase them.

An exact resemblance exists between Maritime Flanders and the opposite coast of England, both in point of elevation above the sea, and of the internal structure and arrangement of the soils. On both sides, strata of clay, silt, and sand, (often mixed with decayed vegetables), are found near the surface; and, in both, these superior materials cover a very deep stratum of blueish or dark-coloured clay, unmixed with extraneous bodies. On both sides they are the lowermost part of the soil, existing between two ridges of high lands||,

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\* Mem. de l'Acad. de Paris, 1789, p. 351.

† Notices des Gaules, p. 461.

‡ Nicholas Bergier, Hist. des Grands Chemins des Romains, Ed. de Bruxelles, vol. II. p. 101.

|| These ridges of high land, both on the British and the Belgic side, must be very similar to each other, since they both contain parts of tropical plants in a fossil state. Cocoa-nuts and fruits of the Areca are found on

on their respective sides of the same narrow sea. These two countries are certainly coeval; and whatever proves that Maritime Flanders has been for many ages out of the sea, must, in my opinion, prove also that the forest we are speaking of was long before that time destroyed and buried under a stratum of soil. Now it seems proved from historical records, carefully collected by several learned members of the Brussels Academy, that no material change has happened to the lowermost part of Maritime Flanders during the period of the last two thousand years\*.

I am therefore inclined to suppose the original catastrophe which buried this forest to be of very ancient date; but I suspect the inroad of the sea, which uncovered the decayed trees of the islands of Sutton, to be comparatively recent. The state of the leaves and of the timber, and also the tradition of the neighbouring people, concur to strengthen this suspicion. Leaves, and other delicate parts of plants, though they may be long preserved in a subterraneous situation, cannot remain uninjured when exposed to the action of the waves and of the air. The people of the country believe that their parish-church once stood on the spot where the islets now are, and was submerged by the inroads of the sea, and that at low water their ancestors could even discover its ruins; that their present church was built to supply the place of that which the waves washed away, and that even their present clock belonged to the old church. So many concomitant circumstances, though weak testimonies, incline me to believe their report; and to suppose that some of the stormy inundations of the North Sea, which in these last centuries have washed away such large tracts of land on its shores, took away a soil resting on clay, and at last uncovered the trees which are the subject of this paper.

the Belgic ridge. The petrified fruits of Sheppey, and other impressions of tropical plants on this side of the water, are well known.

\* Vide several papers in the Brussels Memoirs; also *Journ. Phys.* Vol. XXXIV. p. 48.

XIII. *On an Epidemical Disease among Cats.* By J. F. BLUMENBACH \*.

THE disease among the cats, which prevailed lately in Denmark and various other countries of Europe, and which in Lombardy destroyed a great many of these useful animals, induced the Council of Health at Pavia to make an inquiry into the nature of it, and to cause the result to be published by one of their members, Professor Brera, in a small but interesting pamphlet under the title of *Memoria sull' attuale Epidemia de' Gatti* †.

The cats attacked by this disease seemed dejected and weak, and had an aversion to approach man; crawled about as if under great oppression; would neither eat nor drink; and could not endure any of the three plants of which they are commonly so fond, *Marum verum*, Valerian, and Cat's mint. In the course of the disease the weakness and dullness increased; they could scarcely support themselves on their legs; their hair stood erect; they let their tail hang down, and their head droop so that their neck appeared as if prolonged; their ears were flabby and cold; the eyes seemed smaller, and the pupil contracted; the tongue was dry, and covered with yellow slime; they discharged from the mouth a whitish green foam, were for the most part colicive, breathed short, and had a quick feverish pulse, accompanied with burning heat. They at length became like mere skeletons, were seized with violent convulsions, and generally died on the fourth or fifth day of the disease; which, according to the symptoms, was a nervous fever, accompanied with dejection. It is, however, far from being always mortal; and many of the animals attacked by it recovered again gradually, without any assistance.

\* From *Voigt's Magazin für der neuesten zustande der Naturkunde*, Vol. I, Part 3.

† It was published at Pavia last year (1796), and consists of twenty-six pages quarto.

The method in which this disease was treated was entirely Brownian; that is, half an ounce of Cyprus wine, with a scruple of pulverised valerian root, was given four times a day to the diseased animals: aloes, and the juice of garlic, were administered in some spiritous vehicle, and also fumigations with vinegar. The proposal for destroying every cat attacked by this disease was, with great propriety, rejected; but it was at the same time ordered, that those which died of it should be buried at a sufficient depth in the earth; that the bodies should be covered with lime; and that the places where they were found dead should be washed with vinegar, ley of wood-ashes, or lime-water. It was recommended also to separate, as much as possible, sound animals from those infected; to give them nourishing food; to lay before them, in particular, their three favourite plants; and to fumigate them often with the steam of vinegar.

That excellent physician and naturalist Professor Schacht, of Harderwyk, informed me, by a letter dated in May 1796, that the cats in his neighbourhood had for some weeks been attacked by a disease which bore some resemblance to a prurient eruption. The violent itching occasioned a defluxion of the eyes, which continually watered, and they at length became blind; their teeth at the same time dropped out, and they died soon after with lamentable cries. It had been observed in the preceding months, from February to April, that their cries in the night-time, on account of their pairing, had been extraordinarily strong and loud.

Dr. Darwin, in his *Zoonomia*\*, mentions another epidemic which prevails at times among the cats, and which he calls *Parotidis felina*. It announces itself by a violent fever with inflammation, and abundant suppuration in the region of the salival glands beneath the lower jaw. He compares it to a disease lately known called the Mumps (*Angina parotidea*), and is inclined to believe that it was first communicated to cats by infection from the human race. He men-

\* Vol. II. p. 229.

tions also a disease which affects the neck and head of cats, by which the greater part of these animals in Westphalia died; and refers to a passage in Sauvage's *Nosologia*\*, which however, in an extract of that work in three large volumes octavo †, now before me, I have not been able to find.

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XIV. *On the Preparation of Crayons used for Drawing, from the Paste of Reddle.* By C. F. LOMET ‡.

IN most drawing-schools, and particularly those at a distance from the capital, many difficulties are experienced for want of good crayons. Those sawed from red chalk, which are in common use, are almost always hard, gritty, and often of an unequal consistency; so that the touches in the drawings for which they are used can never have the strength or correctness necessary to produce the desired effect. The only good crayons used in France are manufactured exclusively at Paris, where they are sold very dear: the best sort have been long known by the name of the paste-crayons of *Desmarests*, who apparently was the inventor. As no author who has written on the composition of these crayons has pointed out the proportions of the ingredients necessary to be used, I made many trials with every combination of the substances that appeared to me proper for making them. I rejected those products which did not answer the objects of my research; and I here subjoin those mixtures that gave me satisfactory results.

These pencils are composed of the softer kind of redde, which is an oxyde of iron mixed with earth of an argillaceous nature, and called *bematites*, or bog-ore. It must be incorporated with some agglutinating substance, such as gum, size, or resin; to which sometimes soap is added, to

\* Nosol. cl. X. art. 30. 8.

† Amst. 1763.

‡ From the *Annales de Chimie*, No. 90. an. 7.

soften the composition. Instead of reddle the other red oxides of iron may be used, such as colcothar of vitriol, &c.; and in that case they should be chosen soft to the touch, and of a lively colour; for those used in commerce are often mixed with too much clay, which gives them a dull yellowish cast that ought to be avoided. I attempted to incorporate these substances with the whites of eggs and the albumen of blood; but crayons composed in this manner were not good.

The best reddle, in lumps, should be selected and ground with pure water on a marble slab, as is done in the preparation of colours for painting; taking care to moisten it as much as is necessary to make the grinding stone glide, and to employ as little water as possible. When it is intended to prepare a large quantity of this substance, this operation becomes very difficult and expensive: in that case a different method must be used. The reddle must be pounded and sifted through a fine sieve, then diluted with a large quantity of water in a trough; where, after it has been well stirred round, it should be left a few minutes to settle, in order that the grosser particles may precipitate themselves to the bottom. The water, which is strongly impregnated with the finer particles, is then poured off, and suffered to settle for twenty-four hours. The clear water on the top is then poured off again, and a very fine sediment will thus be obtained, which must be pounded and washed once more. The sediment of the first washing must be treated in the like manner, and the process is repeated until the whole be reduced to the utmost fineness.

The gum, size, or soap, destined to give the crayon the necessary degree of solidity, must be dissolved separately. These solutions must be carefully mixed with the pounded reddle, and the watery particles must be evaporated by being exposed to the sun or to the heat of a gentle fire, taking care to turn the paste often till it has acquired a consistence somewhat harder than butter: the crayons are then to be formed in the moulds.

The moulding may be performed two ways: the first is, to spread out the paste on a board, in which are cut grooves rather broader at the top and round at bottom; and of any length, size, and depth, proportioned to the intended size of the crayons. The second, which is the better method, is to force the paste through a pipe or funnel of an orifice equal to the size of the crayon. The paste thus formed may be left to dry slowly in a cool place under the shade, in order to prevent cracks, which too hasty desiccation might produce. When the rods are dry, they are to be cut into pieces of the desired length: the edges must then be taken off; after which they must receive the first cutting, to give them a blunt point. The last operation is to scrape them, in order to take off the hard outward coat formed on the surface while they are drying, and which would prevent them from making any marks. It may be necessary to rub a small portion of oil into the grooves of the wood, that the paste may not adhere too closely to the moulds.

Gum arabic and isinglass are the two substances to be preferred for mixing with the powder. It will be sufficient to dissolve the gum and soap in cold water; but the isinglass must first be cut into small pieces, then put into hot water, and dissolved in *balneo marie*. These solutions should be well diluted with water, that they may be made to pass through a hair sieve in order to remove any foreign particles. As it is difficult to incorporate the paste with the isinglass, they must both be heated and mixed over a fire with a heat equal to that of boiling water. The paste must be well mixed before it is moulded, in order that it may be uniformly incorporated with the solution, and that there may not remain any hard lumps. The best way would be to beat it with a pestle or mallet, and to pound it again for some time before it is put into the moulds.

No soap must be employed but for those crayons in which gum is used. In all the trials I have made with isinglass and soap,

soap, not one of them succeeded: and it must necessarily be so; for, the excess of alkali in the soap, operating on the gelatinous matter, destroys its agglutinating quality. As the crayons for which soap has been used are of a browner cast, it would appear that this combination abstracts the oxygen from a part of the red oxyde of iron, and gives it a brown tint by making it approach the state of martial æthiops. I have remarked, that all the pastes prepared with oxyde of iron, even when pure water alone is used, grow brown on the exterior surface as they dry: this takes place in a more sensible manner when they are exposed to the action of the sun; which seems to arise from the light abstracting a portion of oxygen from the oxyde of iron. At some future period I shall enter into a farther inquiry respecting the chemical properties of these preparations; but at present I shall content myself with pointing out the processes which have constantly succeeded with me, and in such a way that they may be put in practice any where with success.

The crayons composed in this manner have every good property that can be desired; they do not cost one quarter the common price: but it must be observed, that their composition requires great nicety in regard to the quantity of the materials, because the least variation occasions considerable difference in the quality of the paste. Particular care must also be taken to guard against the errors that may arise from the waste, which is unavoidable during the course of the operation. The best means to prevent it will be, to fix by experiments the quantity of water and of ingredients which the pounded reddle and the solutions form before the mixtures are made. By means of the following tables, which exhibit the quantity of ingredients to be used for the different kinds of crayons, it will be easy to know what proportion of gum, isinglass, or soap, must be employed for a determined quantity of reddle, or red oxyde of iron.

*Indication*



*Indication of the Substances to be used, their Quantities, and what they will produce.*

I. Dry reddle, or red oxyde of iron, 1 ounce; gum arabic, dry, 18 grains.—These crayons are very tender, but they may be employed for large designs. As they are the kind in which the least gum is used, they have not sufficient consistence for any other purpose.

II. Reddle, &c. 1 ounce; gum 21 grains.—Strong crayons, a little tender, but excellent for large drawings.

III. Reddle 1 ounce, gum 24 grains, or rather  $25\frac{1}{2}$  grains.—Soft and solid crayons: they are the best that can be employed for common use.

IV. Reddle 1 ounce, gum 27 grains.—Crayons rather firm, but not hard; useful for drawings that require delicacy.

V. Reddle 1 ounce, gum 30 grains.—Very firm crayons, proper for drawings in which every stroke is intended to be given.

VI. Reddle 1 ounce, gum 33 grains.—Very hard crayons, which cannot be used without some force. The largest quantity of gum that can be employed is used in their composition: with more they would be useless.

VII. Reddle 1 ounce, gum 22 grains, white hard soap 30 grains.—These crayons have a little browner cast than the former; they are of a very good consistence, and can be easily cut. All crayons, however, in the composition of which soap is employed, are attended with this fault, that the strokes they make have a shining appearance if the touches are repeated a little too strongly. No other experiment with soap succeeded. These crayons have a perfect resemblance to those made by Desmarests.

VIII. Reddle 1 ounce, isinglass 36 grains.—Crayons of a brilliant colour, and excellent for use. If less isinglass is employed they become brittle; and if more, they are too hard.

## XV. Description of HUMBOLT'S New Portable Barometer\*.

TO have a barometer composed of several parts which could be easily put together, and which should correct itself at each observation like an astronomical instrument, were the reasons which induced M. Humbolt to devise the present construction. Tralles, the learned astronomer of Berne, has judiciously observed, that all barometers are liable to be broken when the tube is fixed to the scale which belongs to it. In Humbolt's barometer the tube is distinct from the scale; and when the tube breaks, its place can be supplied by another even on the top of a mountain. The tube, the lower part of which is represented by *abc* (fig. 1. pl. VII.) is cemented into an iron one *bc*, two inches long, terminating in a nut *c*, which receives a screw to the depth of  $2\frac{1}{2}$  lines: the end of the screw is square. When the tube is filled with mercury, and screwed close, it is put into a tube of copper lined with flannel, and covered on the outside with leather. This case may be carried as a cane; the head *d* of the screw being kept, as far as possible, in a vertical position. If the entrance of air be apprehended, it will lodge itself under *d*. In that case turn the screw and pour a drop of mercury upon it before it is shut. The whole tube may be examined to see that the mercury is not separated by air bubbles; an advantage wanting in the English barometers, in which the tubes are half concealed. The mahogany pillar *cgf* (fig. 2.) contains the mercury, to be poured into it after it has been screwed into its stand *gb* (fig. 3.), supported by three feet that fold over each other. The interior part of the column forms a hollow parallelopipedon, the square aperture of which is exactly equal in size to the square of the screw *cd*. In pushing the tube *klma* (fig. 4.) into this aperture until *cd* be above the level of the mercury, you turn the tube to the right, by laying hold of it with one hand between *lm*.

\* From the *Journal de Physique*, an. 7.

As the square *cd* cannot then turn, being held fast in the pillar, the screw is loosened, *cd* sinks down floating on the mercury, and the atmospheric air has free communication with the mercury in the tube. The Torricellian vacuum is formed under *k*, and the mass of mercury in the column is increased. The scale *no* (fig. 4.) is attached to a wooden rod *nop*, formed of two pieces of timber of a different kind, and screwed at *p* and *q* to the mahogany pillar. Turn the three screws *rrr* until the vertical position of the instrument is announced by the plummet *s*. If you fix the scale to the tube *ka*, by screwing close the screws *l* and *m*, there will be too much mercury in the pillar. The point *o* of the barometer is placed in the aperture of the cock *s*, and you will have a *constant level* by opening that cock and suffering the mercury, which you must collect in a small vase, to flow down. In order that the ivory cock *s* may not open of itself, there is, at *t*, a fork which by a screw can be fixed in each position to prevent it. When the observation is made, you place in *ge* a small cushion, or covering, held by two screws *vv*, which prevent the escape of the mercury while you are walking; or you dismount the instrument by again pushing the tube *k l m* (unscrewed at *m* and *l*) to the bottom of the pillar *f*, where you turn the square *cd*. The Torricellian vacuum is by these means filled, and you turn the tube to the left, holding it with your hand between *l* and *m* until you observe that *cd* has caught, and that the aperture of the tube is closed. You then draw out the tube with *cd* well shut in order to inclose it in its case. There is a loss of a few drops of mercury which adhere to the iron. One of these instruments, constructed two years ago, has remained unhurt during a great many journies over the most rugged roads and the steepest mountains. More time is required to make an observation with it than with a common barometer; but it is the only one perhaps which could with certainty be used, were it to become deranged even in the deserts of Thibet.

These instruments are now made at Berlin, Weimar, Dresden, Vienna, and Paris. On coming from a cold to a very warm temperature the screw *cd* must be loosed before you approach the fire. This instrument has an advantage by which it is distinguished from all others: it is the only one in which the size of the Torricellian vacuum depends on the observer: the height of the mercury remains the same to whatever depth it be plunged in the mercury, provided you take care each time to adjust the level by the cock. Muscati has proved, that the barometric height is affected by the size of the vacuum on account of the attraction of the glass in *k*, and because the *minimum* of air which the vacuum contains is more or less dilated. In Humbolt's barometer, the same Torricellian vacuum exists on the tops of the mountains as in the valleys.

The different pieces of which this instrument consists are contained in one cylinder, which may be carried on the shoulder like a fuzee. Several tubes may be contained also in a walking-stick. Having for two years measured the height of different mountains with Humbolt's barometer, and others constructed on the old principles, no sensible differences were observed, though this operation, for various reasons explained by Tremblay, is still very far from perfection.

#### XVI. *Postscript to Volta's Letters on Animal Electricity* \*.

SOME new facts, lately discovered, seem to shew that the immediate cause which excites the electric fluid, and puts it in motion, whether it be an attractive or a repulsive power, is to be ascribed much rather to the mutual contact of two different metals, than to their contact with moist conductors. But, though it cannot be denied that in the latter case there exists an action, it is proved that it exerts itself in a far more

\* See page 59 and 163.

considerable degree when the two metals mutually touch each other. There arises by the mutual contact, for example, of silver and tin, an action or power by which the former communicates the electric fluid, and the latter receives it; or the silver suffers it to escape, and the tin attracts it. This produces, when the circle is rendered complete by moist conductors, a stream, or continual circulation of the fluid. When the circle is complete, there is an accumulation in the tin at the expence of the silver; which indeed is very small, and far under the point necessary to enable it to announce itself by the most delicate electrometer. I have however been able, by the assistance of my condenser, constructed on a new plan, and still better by Nicholson's Doubler, to render it very perceptible: I shall here communicate the result obtained by my experiments, which I made some time ago with great satisfaction.

EXPER. I. The three plates of the doubler are of brass. I took two strong wires, one of silver and the other of tin, and brought the former into contact with the moveable plate, and the other with one of the fixed plates; while they both rested on the table, or, what is better, on moist paste-board, or any other moist conductor, so as to be in communication by the intervention of one or more conductors of the second class. I suffered the apparatus to remain some hours in this state, then removed the two wires, and put the machine in motion. After 20, 30, or 40 revolutions, (or more when the atmosphere was not dry, or the insulation imperfect,) I brought one of my straw electrometers into contact with the moveable plate, and observed indications of positive electricity (+E) which arose to 4, 6, 10 degrees, and more. If I suffered it to touch the fixed plates, I had the corresponding indications of the opposite kind of electricity (-E).

The silver, therefore, poured the elastic fluid into the brass plate when it had been some time in contact with it; and the tin attracted it from the other plate, which was also of

brass, while in contact with it. This was confirmed by the following experiment, which is a real *experimentum crucis*.

II. I reversed the experiment, so that the silver was in contact with one of the fixed plates, and the tin with the moveable one. The electricity which I obtained from the latter, after the apparatus had remained a sufficient time in that position, was negative ( $-E$ ); while that of the fixed plate was positive ( $+E$ ).

III. I applied only the tin wire to the moveable plate, and insulated the two fixed ones, or brought them into communication with the table or any other moist conductors with which the tin wire was in contact. This simple contact of the tin with the brass, of which the moveable plate consists, is sufficient to excite in it a very small degree of negative electricity; only a longer time is required.

Those acquainted with the action of electric atmospheres, and the construction of the doubler, will need no farther explanation to enable them to comprehend the mode of action of this very ingenious instrument; how the electricity, once obtained from the moveable plate, must occasion an opposite kind in the fixed plates, and *vice versa*; how the opposite kinds of electricity are increased by each revolution of the machine, &c. In the present experiment, therefore, when the moveable plate is  $-E$ , the fixed plate must be  $+E$ .

III. This is the reverse of the former. The piece of tin was applied to one of the fixed plates, and the moveable one was insulated from all metallic contact. The result was now reversed; that is, the fixed plates were electrified negatively, and the moveable one had positive electricity.

All these experiments succeed much better, and in a shorter time, if, during the mutual contact of the different metals, the moveable plate be opposite to either of the other two that are fixed; but still better when a piece of thick paper, such as a card, not moist, and of a thickness equal to the intermediate space, is placed between the two plates that stand opposite to each other. It is of advantage to leave the card

some

some time in its place, and not to remove it till the moment when the metals in contact are removed and the machine put in motion. To render the insulation complete, and make the contact of the metals immediate, without the least moisture, which would be highly prejudicial, it will be proper to place the apparatus in the sun. Half an hour, and often less, will then be sufficient to obtain the required electricity, &c.; whereas, in other cases, several hours are necessary before the desired result can be obtained. A representation of this experiment is exhibited by fig. 21, 22, 23 and 24, (Plate I.) L L L (fig. 21 and 22) are the three brass plates of the doubler; A the piece of silver which is in contact with one of these plates; E the piece of tin applied to the other plate, which is opposite to the former; *aa* the moist conductor, or chain of moist conductors which form a communication with the pieces of metal. When the silver, as in fig. 21, is in contact with the anterior moveable plate, it gives up to it a little of the electric fluid, and the latter accumulates as much of it as possible; consequently the electricity of the plate becomes positive, as the sign + of the plate shews: whereas the tin attracts the electric fluid from the corresponding fixed plate, which by these means has negative electricity, as the sign (—) of the plate indicates; and it even communicates this electricity to the other fixed plate, which therefore has the sign (—) also.

In fig. 22, every thing is reversed: the moveable plate is negatively electrified (— E), while the two fixed plates become positive (+ E).

Lastly, in the 23d and 24th figure, it is seen, that the tin abstracts the electric fluid from the brass plate with which it is in contact. This plate is therefore negatively electrified, or has — E; and by the action of its atmosphere occasions positive electricity (+ E) in the other plate standing opposite, which is in communication, either with the third plate, as fig. 23, or, what is still better, with other conductors, as fig. 24. These opposite electricities increase af-

terwards with each revolution of the machine ; the action of which, according to the theory of electric atmospheres, produces this effect to the degree mentioned, and justifies the appellation of doubler of electricity, which has been given to this instrument.

I now come to the experiments, which show that we are to seek for the cause which calls forth the action of the electric fluid ; which excites it, of whatever kind it be ; determines its transition, &c. much rather in the mutual contact of the metals, than in the contact of the moist conductors with these metals. Though, according to every circumstance, we must admit some action of this kind in the latter contact, it cannot be denied that the former is certainly the most effectual. At present I shall only mention the two following experiments, which I contrived in such a manner that they may serve to explain a question of this kind.

V. I left the two fixed plates of brass without making any alteration ; took off the third moveable plate, and supplied its place by one of tin ; and arranged the machine in such a manner that the latter stood opposite to one of the other two plates. I then applied to this tin plate a bit of brass, and to the opposite fixed plate of brass a piece of tin. After a convenient time, (for example an hour, when the weather was perfectly dry,) I took away the two pieces of metal, or only that of brass, and made the moveable plate of tin, which was in contact with the piece of brass, to revolve about thirty times. It then gave me very perceptible marks of positive electricity.

VI. I reversed the former experiment, and made the piece of brass touch the brass plate, and the piece of tin the plate of the same metal. I, however, obtained nothing, or almost nothing ; even when the apparatus was left a much longer time in that situation, and when the machine had made twice or three times as many revolutions.

These two experiments are represented by fig. 25 and 26 : where L is the piece of brass ; E that of tin ; and *aa* the moist



moist conductors which connect the two different pieces of metal.

In the arrangement of fig. 26, the same contact of different metals, viz. brass on the one side, and tin on the other, with the same kind of moist conductor, takes place, as well as in the preceding experiment of fig. 25. The addition of the electric fluid in the one, and the abstraction of it in the other, ought therefore equally to take place, though in an inverted order, when the action on the fluid calls forth the moving power, by this contact of the two metals L, E, with the moist conductor between them; and yet this is not the case, as no signs of electricity are obtained even after a long time, and when the machine has been caused to make twice or three times as many revolutions. The condition essentially necessary to obtain electricity is, that the different metals must be in contact with each other, which is the case in fig. 25, but not in fig. 26.

When the machine has been repeatedly turned, something may be obtained. This arises either from some small remains of old electricity, which could not be destroyed or dissipated in the time during which the arrangement of fig. 26 was continued; or even from fresh electricity, which the moveable plate may have obtained from the atmosphere or vapours during the pretty considerable time of the machine being in a state of revolution; or some accidental difference, either between the two tin or the two brass pieces, may be the cause of some action on the electric fluid, or of some derangement in regard to the equilibrium. In the last place, the contact of the moist conductor with the tin on the one side, or with the brass on the other, may have a different action, which, in my opinion, must be very small, but yet is not entirely without effect.

As it is now proved that, according to the arrangement of the sixth experiment, nothing, or almost nothing, is obtained by 40, 60, and even 80 revolutions of the doubler, while a great deal is obtained by that of the fifth with 20

or 30, we must therefore conclude that the contact of two metals of a different kind with moist conductors, without the mutual contact of these metals themselves, (which is wanting in the sixth experiment, where brass is in contact with brass, and tin with tin,) produces nothing or almost nothing; and that, on the contrary, the mutual contact of the two metals of a different kind, which takes place in the fifth experiment, produces the whole, or almost the whole, effect.

XVII. *A Statement of the Progress in the Vaccine Inoculation; and Experiments to determine some important Facts belonging to the Vaccine Disease.* By GEORGE PEARSON, M.D. F.R.S. *Physician to St. George's Hospital, &c.*

THE collection of testimonies which I published, in November last, in my *Inquiry concerning the History of the Cow-pox*; and the Circular Letter, which I issued in March, stating the progress of the *Vaccine Inoculation*, and containing thread impregnated with *matter*, have procured me much information. In particular, through the recommendation of the *Surgeon-general, Thomas Keate, Esq.* the new practice has been introduced into the army; of which a valuable report has been already communicated. I have been also so fortunate as to obtain permission to practise the *new inoculation* in certain situations where great numbers would have been inoculated for the small-pox. The cases from these sources, and a pretty large stock from private practice, form a valuable body of evidence, by means of which the professional public will be enabled to estimate (I do not say precisely) the value of the *new practice*; and also answer many of the queries, and supply some of the deficient parts of the history of the vaccine disease, which were stated in the *Inquiry* above mentioned. But such are my occupations at present, and in all likelihood such they will be for a considerable time, that I cannot at this time arrange, for the use of the

the public, the valuable materials transmitted to me. It will, however, perhaps be not without utility at this time first to state a few general results from the vaccine inoculation; and secondly, to relate some *trials*, from which I apprehend conclusions can warrantably be drawn to promote the investigation now going forward.

Not much more than six months have elapsed since the opportunity was afforded, by the breaking out of the *vaccine disease* in two principal milch farms near London, of obtaining matter for propagating the same disease among human creatures. The *new inoculation* was immediately introduced in London, and soon afterwards in the neighbourhood, as well as in many provincial situations. It is with sincere satisfaction that we can now reckon, at the fewest, 2000 persons who have passed through the cow-pox by inoculation. But in this number I include the very large proportion furnished by him who, so beneficially to the public, and honourably to himself, possesses the office of physician to the Small-pox Hospital. From the above experience we receive, as I expected, important information.

I. Of the above number it appears that *one* patient died; (Woodville's Reports, p. 151.) and to avoid controversy, let us allow that the death was occasioned solely by the inoculation. Now, according to the justest calculation I have been able to make, as in the inoculated small-pox one in 200 \* dies from the disease, it is evident, in the present state of

\* I am fully aware that so great a proportion as one in 200 will not be allowed by many practitioners. And to persons who have been told, and believe, that inoculation for the small-pox "scarcely ever does any harm"—that certain practitioners have inoculated many thousands without losing a patient—that others have told their friends "they never had a fatal inoculated case in their whole lives"—I say to such persons, no advantage, on the score of saving life, will be allowed from the cow-pox. But I have conversed with many candid and experienced practitioners, and they are well satisfied that I am warranted in the above statement of deaths in the inoculated variola. I beg leave to say farther, that I believe more persons

of the practice, that the proportion of fatal cases in the inoculated small-pox, to the inoculated cow-pox, is as 10 to 1.

2. The constitutional affection, or fever, which occurs in the cow-pox about the 9th day after inoculation, is much more considerable in many cases than was apprehended from the first account by Dr. Jenner, although in a great proportion of cases it is extremely slight, and in many cannot be observed at all. But I must correct my statement in March last, in which I said, "Although the extreme cases of the severe kind, which ordinarily occur in the same number of cases in the inoculated small-pox, did not occur in the new practice, and although many of the patients were even more slightly disordered constitutionally, yet the whole amount of the constitutional illness seemed to be as great as in the same number of patients in the inoculated small-pox." Since that report, or at least for the last four months, as far as I have observed and been able to learn from others, the whole amount of the constitutional illness was not one half of the whole amount in an equal number of patients inoculated for the small-pox. Now, whether the greater mildness of the disease depended on the different state of the human constitution in the summer from that of winter, as seems to me most probable; or that it depended on the difference in the state of the vaccine matter, must be determined by future experience in the same seasons.

3. The most remarkable difference in the practice of the last winter, and present summer, has been with regard to the eruptions which so often occurred, especially in the Small-pox Hospital; which eruptions, in many instances, could not

persons in proportion have died of the inoculated small-pox within a few years, than died in the same time 20 years ago. And this may be accounted for from the unwarrantable assertions of many inoculators, from whom a great part of the public have imbibed the opinion, that the inoculated small-pox was not attended with any danger; hence the practice is often trusted in the hands of persons not sufficiently acquainted with the treatment fit for different states of the human constitution.

be distinguished from those of the small-pox, and which were wholly unexpected from the original description by Dr. Jenner. No explanation hitherto given conflicts with the observations relative to these eruptive cases: but the facts are as Dr. Woodville states (*Med. Mag.*), that they have occurred much less frequently this summer than in the spring and winter preceding. In my private practice, not a single case with eruptions resembling the small-pox has occurred these last four months, and but a small proportion with any eruptions of other kinds. From my correspondents I have not had a single case of eruptions like the variolous since that of Dr. Redfearne's of Lynn; not one of this sort in Mr. Kelson's, of Seven Oaks, report of about 100 patients; not one in Dr. Mitchell's, of Chatham, of about 50 patients; not one in the report of near 100 patients from Dr. Harrison of Horncastle, communicated to the Rt. Hon. Sir Joseph Banks; and, in short, not one case with these eruptions appears in the accounts from my other correspondents.

4. The arms have manifested, in many instances, a much more extensively spreading red areola around the inoculated part than is usual in the small-pox; which redness sometimes extended over the greater part of the whole arm. This appearance is very alarming to both the patient and the inexperienced practitioner; but no danger seems to be attendant on such a state of the parts, for it disappears in at most two or three days, by no means gives pain in proportion to its appearance, and, in the cases I have seen, affects the constitution very little. I would rather call this spreading redness of the skin *erythema* than erysipelas. As to phagedenic ulcers, as they have been called, ensuing from the inoculated part, many fore arms have been produced; but nine out of ten were occasioned, or at least much aggravated, by the tightness of the clothes; by allowing the linen to stick to the fore; by scratching the pustule; and sometimes by emollient poultices. The experience we have had, then, since January last, in London and in the country, does not agree exactly.

ably with Dr. Jenner's account concerning the state of the arms: he thinks some new applications of a caustic nature necessary, in many cases, to prevent secondary symptoms from the sores; but in Dr. Woodville's Report, p. 155, my correspondents, and my own practice, there has not been found any want of applications for such a purpose.

5. Concerning the important point of the certainty of the action of the cow-pox on the human constitution in producing unsusceptibility of taking subsequently the small-pox; I can only at present say, that I have inoculated many scores with small-pox matter after the vaccine disease, and never with the effect of exciting the small-pox. But I have had accounts sent to me, not of people taking the small-pox after the inoculated cow-pox, but of these taking the small-pox after the cow-pox in the casual way. I have, indeed, been desired to see even some of my own patients who, I was acquainted, had taken the small-pox after the cow-pox; but these cases turned out to be either those in which the cow-pox had not in reality preceded, or they were cases of merely local affection from the inoculated small-pox. With respect to the facts of other practitioners, I shall at a future time make some remarks on them, to render their accounts consistent with those of Dr. Jenner, Dr. Woodville, and mine. In the mean time I will not allow that any person's evidence is on this point much to be depended upon, unless he really know what are characters of the cow-pox pustule, and what are those of the variolous and some other common eruptions.

From the preceding general results, without entering into a more particular account, I think we may safely conclude, that the cow-pox inoculation is attended with advantages sufficient to force its way speedily into general practice, and that of course it will supersede and ultimately extinguish the small-pox: but this conclusion is only drawn provisionally, *viz.* that no new facts shall arise adverse to the experience now possessed.

With regard to the second object of this paper, Dr. Jen-

ner, very usefully to human society, and very honourably to himself, first published some FACTS, which I thought it my duty, in common with other members of the profession, to investigate, and have laid before the public. Among these facts the 4th and 5th were asserted by me in these terms:

IV. *A person having been affected with the specific fever and local disease produced by the cow-pox poison, is liable to be again affected, as before, by the same poison; and yet such person is not susceptible of the small-pox.*

V. *A person is susceptible of the cow-pox who has antecedently been affected with the small-pox.*

Neither of these facts being supported by any analogy, a great part of the public seemed inclined to disbelieve them; and not only inclined to disbelieve these facts; but the credit of the others was for obvious reasons thereby weakened. It may be seen in my *Inquiry*, that I thought the assertions stood in need of confirmation, which I was not only unable to procure, but contravening evidence was obtained. Some of my correspondents not only asserted that men were not affected more than once, but that the same cows had not been known to be affected more than once. It was also positively asserted by some, that "a person is not liable to the infection of the cow-pox after going through the small-pox, (p. 49, *Inquiry*;) and I saw persons pitted with the small-pox who had been much exposed to the cow-pox without taking it, (*Ibid.* p. 50.) Notwithstanding my confidence in Dr. Jenner's evidence, I could not help pointing out, in the following words, what I apprehended was a source of error in both cases:—"The evidence for this fact (*viz.* IV.), to my apprehension, only proves satisfactorily that the local affection of the cow-pox may occur in the same person more than once; but whether the peculiar fever also occurs more than once in the same person from the cow-pox poison does not appear certain, and must be determined by future observations made with a particular view to this point." Farther: I was so dissatisfied that I wrote to Dr. Jenner to

answer

answer my query, Whether, in the instances of the cow-pox occurring more than once in the same person, it was certain that the specific fever was present more than once? The Doctor very obligingly answered my letter, and says, (see Dr. Jenner's Letter, p. 99. of my *Inquiry*,) "You may be assured that a person may be repeatedly affected *both locally and generally* by the cow-pox; two instances of which I have adduced, and have many more in my recollection." But he very candidly adds: "Nevertheless, on this important point I have some reason to suspect, that my discriminations have not been, till lately, sufficiently nice."

With respect to Fact V. I said in my *Inquiry*, p. 49: "It seems sufficiently authenticated that people may have the cow-pox after they have had the small-pox; but it will require more nice attention to satisfy the query, Whether, in such cases, the cow-pox affects the whole constitution, or is only a local affection?" Subsequently to this observation I find Dr. Jenner himself, from a theoretical consideration, offers as a "conjecture what experiment must finally determine that they who have had the small-pox are not afterwards susceptible of the primary action of the cow-pox virus." (*Farther Observations, &c.* by E. Jenner, M.D. &c. p. 32.)

I shall now relate the *trials* I have instituted, and the *observations* I have made, to obtain *determinations* with respect to these important questions of facts.

*Trials to determine whether or not Persons are susceptible of having the COW-POX PUSTULE and FEVER, who have undergone the Small-pox.*

The four first-named gentlemen being engaged with me in prosecuting physical inquiries, were desirous to experience, in their own persons, the effects of the *vaccine poison*.

1. Mr. Dangerfield was inoculated in one arm by means of a puncture with a lancet stained with fresh but dried matter, rendered fluid by steam just before it was inserted. The other arm was inoculated with thread impregnated with *vaccine*



*vaccine matter* by passing it through the skin. On viewing the arms in three days time, that with the thread appeared inflamed, showing a red elevated small spot; the other arm, which had been punctured, barely shewed a red mark. The punctures had smarted for about twenty-four hours, but no other effects were produced. These red spots disappeared in a few days.

In three weeks further the inoculation was again instituted, but with fluid lymph applied, immediately from the pustule of a patient present, to punctures in each arm. More smarting and more inflammation were produced by this inoculation than by the former. A small quantity of pus was produced in the little red spots from the punctures in about six or seven days, but no disorder arose in the whole constitution.

Mr. Dangerfield was next inoculated in one arm with variolous matter. In the evening of the day of inoculation inflammation appeared, which increased to a greater degree and extent than from the vaccine inoculations. A small phlegmonic tumor in the part inoculated with variolous matter continued for a fortnight, during which time it suppurated, and the pus from it did not heal in less than three weeks further. There was no constitutional affection; but there was pain in the arm-pit in about five days from the inoculation.

2. Mr. Pollock was inoculated in each arm with a lancet armed with fluid matter immediately on taking it from a patient. A little smarting was felt for a day or two, and the parts inoculated were red for several days; but no pustules arose, nor constitutional affection.

3. Mr. Perkins was inoculated by puncturing *one arm* with a lancet stained with recent *vaccine matter*, and the other was inoculated with *variolous matter*. A red spot was seen on each of the parts inoculated the day following; and an itching sensation, especially from the *vaccine matter*, was experienced for a day or two. The parts remained elevated and inflamed a little for a few days further, and then got

well

well without suppurating, or being attended by any general disorder.

4. Mr. Armitage, whose constitution was fat and muscular, was inoculated in each arm, with a lancet stained with limpid vaccine matter, immediately on taking it from a patient present. A small red spot was observed the day following, and a little burning sensation was complained of; the red spots grew larger and larger for four or five days, and at length produced a small unequal hard tumor, in which a little pus was generated; but the parts soon got well without any attending disorder of the whole constitution.

In a fortnight after this, each arm was inoculated with variolous matter. More inflammation than from the vaccine inoculation arose in a few days, with small tumors, which suppurated: the parts inoculated remained sore for more than a fortnight, but no feverish symptoms ever appeared.

5. G. P. a boy 12 years of age, who had gone through the small-pox ten years before, was inoculated in one arm with recent vaccine matter, which had been dried on a lancet, and was moistened just before it was inserted. The day following not so much as a red spot of the part inoculated was seen, nor had there been any uneasy sensation. He was therefore inoculated a second time, but with fluid lymph immediately from a patient.

The day after the second inoculation an itching sensation of the punctured part was complained of, which continued for two or three days. The part punctured had a small red elevated spot upon it the day after the inoculation, which grew gradually larger for four or five days, and became a little phlegmonic tumor, but without any red surrounding areola. In a few days the little swelling subsided, but a red and rather sore spot remained for a week longer. No disorder of the whole constitution was perceived.

6. Dr. Woodville inoculated me in one arm with vaccine lymph

lymph from a subject present. The punctured part smarted a little all the remainder of the day of the inoculation, and also the day following. In twenty-four hours a red spot on the inoculated part was seen exactly like that which is often seen in the same time when either the vaccine or variolous infection has taken effect, and which increased for another day; but after this the redness vanished, and no sore was left.

I once accidentally punctured the back of my hand with a lancet which had fluid vaccine matter upon it. The consequence was, a circumscribed, very small, red, hard tumor: this remained for a fortnight, then suppurated, and afterwards burst. The part soon healed, but left a very small superficial cicatrix.

As belonging to this head, I mention, that I have seen several instances of nurses having small, red, conical tumors on their lips and cheeks, and sometimes hands; evidently from the application of cow-pox matter of the children under their care during the vaccine inoculation. These little tumors sometimes remained for several weeks, and a particle of pus was formed in them: they never were attended by any fever symptoms, nor by any surrounding erythematous areola.—I here speak of nurses who had long before passed through the small-pox.

I have no hesitation to refer the following cases to this head of unsusceptibility of taking the cow-pox to having previously gone through the small-pox.

A servant of Thomas King, Esq. about 18 years of age, was brought up during his infancy under circumstances in which he could get no testimony to his having had, or *not* having had, the small-pox. Not having undergone this disease to his own knowledge, it was thought adviseable, in order to resist the small-pox, with which his fellow-servant was seized, to inoculate him for the cow-pox. This I did on Thursday the 23d of March, in one arm with matter on a lancet, and in the other with dried matter on a bit of thread.

4th Day, Sunday 26. The parts inoculated had smarted

for the two first days, and they now were red and a little elevated, as if the infection had taken effect.

*6th Day, Tuesday 28.* Inflammation had almost entirely gone off: inoculated a second time in both arms with matter from a different patient.

*3d Day of second Inoculation, Thursday 30.* Punctured parts appeared inflamed.

*6th Day, Sunday April 2.* Inflammation had disappeared. Inoculated a third time with limpid fluid matter from a patient present, and with which matter I had excited the vaccine disease in several persons.

*7th Day of third Inoculation, Friday April 7.* The parts inoculated had inflamed and felt painful for two or three days, but were now well.—Inoculated him a fourth time with *small-pox* matter in both arms. A little inflammation arose, but nothing more.

This young man frequently visited his fellow-servant in the small-pox, and shook hands with him, at the Small-pox Hospital, while under my care for the cow-pox inoculation. In this case, either the small-pox had already affected the constitution, or some other disposition existed, rendering it equally unsusceptible of the small-pox and cow-pox.

From Dr. Mitchell of Chatham, whose report is now before me, I learn, that there were several instances of soldiers to whom the cow-pox could not be communicated; and although they had no recollection themselves of having had the small-pox, it was most probable they had passed through it. If I had seen any case of genuine cow-pox pustule and specific fever in a constitution which had previously suffered the small-pox, I should have related it; but I ought to mention that such a case has fallen under the observation of Dr. Woodville, (*Reports*, p. 52 and 143.) I shall never object to the testimony of so experienced a physician without more than usual consideration; but I cannot avoid here observing, that the evidence in his case, of the patient having had the small-pox *when a child*, is merely that of the patient; and

I submit

I submit to Dr. Woodville, whether or not that evidence is admissible to build upon, now that we have the above unequivocal contravening cases of the fact asserted. But I trust the Doctor will be less tenacious of this instance, as he himself tells us that he failed to excite the vaccine disease by inoculating several patients who were recovering from the natural small-pox. (*Reports*, p. 144.)

Whatever impression the above instances may have made on my own mind, I do think they will produce conviction in the mind of every practitioner, *that it is a law of the human animal œconomy to be rendered unsusceptible of the cow-pox fever and specific pustule by undergoing the small-pox.* Hence I find that my expectation of the hands of physic being strengthened by the possession of a sure means of exciting an innocent fever is not realised, (*Inquiry*, p. 81;) but I feel some consolation from the prospect of the new inoculation being more speedily introduced by the removal of one obstacle, viz. the fears of many persons, who have already passed through the small-pox, that they would be liable to the cow-pox, if the diffusion of the infection of it became extensive by the vaccine inoculation. Another advantage suggested in my *Inquiry*, p. 92, is now, I think, greatly confirmed; namely, *an advantage for those who are not certain whether or not they have had the small-pox, but possess so great a dread of this disease as not to be able to submit to inoculation for it.* I congratulate such persons on the discovery of a test to which I apprehend the more timorous minds will submit: for if the *specific pustule* and *fever* do not take place from the inoculation of the cow-pox poison, they may be assured, that either they have already passed through the small-pox, or that their constitutions are not susceptible of it.

It now seems to me, that the following facts are established on the ground of experience:—

I. *A constitution which has undergone the small-pox, is unsusceptible of again undergoing this disease.*

II. *A constitution which has not undergone the small-pox, but which has undergone the cow-pox, is unsusceptible of undergoing the small-pox.*

III. *A constitution which has not undergone the cow-pox, but which has undergone the small-pox, is unsusceptible of undergoing the cow-pox.*

Now, if the variolous poison destroys the susceptibility of the constitution to the future agency of this poison, in the respect of its producing the small-pox; and if the cow-pox poison destroys the susceptibility of the constitution to the future agency of the variolous poison, in the respect of its producing the small-pox; and if the variolous poison destroys the susceptibility of the constitution to the future agency of the vaccine poison, in the respect of its producing the cow-pox; it seems demonstrated, that the same state of unsusceptibility of the constitution, with respect to the future agency of the variolous poison, is produced equally by the agency of the variolous poison, and by the vaccine poison. But if the variolous poison produces unsusceptibility of the constitution to the future agency of the vaccine poison, and the vaccine poison produces unsusceptibility to the future agency of the variolous poison, it seems also demonstrable, that the following 4th proposition is true; viz.

IV. *A constitution which has undergone the vaccine disease, is unsusceptible of again undergoing that disease from the agency of the vaccine poison: because a state of unsusceptibility, with respect to the agency of the variolous poison, is produced by the vaccine poison (2d propos.); and a state of unsusceptibility, with respect to the agency of the vaccine poison, is produced by the variolous poison (3d propos.): but the state of the constitution being the same in the two cases, whether it be produced by the variolous or vaccine poison, with respect to unsusceptibility, it seems inevitably, in course, that unsusceptibility of the constitution to the future agency of the vaccine poison is produced by the vaccine disease:*

disease: and the demonstration in course could be given of proposition 1, on the ground of the 2d and 3d proposition, that unofsceptibility of the constitution to the agency of the variolous poison is produced by the variolous disease, if this were not already proved by abundant experience. At a future time, however, I shall relate the observations and experiments to confirm this *a priori* conclusion; 1st, because these proofs will increase the validity of the 3d proposition; and 2dly, because I do not mean to offer this demonstration as infallible, like mathematical.

From the preceding reasoning it may be imagined, that I consider the cow-pox and small-pox as only varieties of the same species of disease; and that therefore the name *variola vaccina* is appropriate, although I endeavoured to show that it was unjust, and tended to mislead, by giving erroneous notions, (*Inquiry*, p. 108). But it must here enter into our contemplation, that the same state of an animal or other substance, in a certain respect, may be produced by very different things; and the phenomena attending their agency may be very different from one another. It is so in the instances under consideration; and further, in order to establish resembling things to be *varieties of the same species*, we ought to be able to trace them to one common origin, or to show that they all agree in what should be reckoned essential properties. Now hitherto it has not appeared that the cow-pox has arisen from the small-pox, or the small-pox from the cow-pox. If it be said, that in some of the eruptive instances of the cow-pox, the pustules could not be distinguished from the small-pox, it should be considered that it has not been yet shown, that in any case the small-pox has changed into the cow-pox;—that the cow is susceptible by inoculation of the human matter of the cow-pox, but not of the small-pox; and that the pustules resembling the small-pox, which occur in the cow-pox, afford matter which, I believe, produces in some cases (if not, perhaps, in so great a proportion as originally) the cow-pox in its usual mild way,

*viz.* a pustule in the inoculated part only, and a slight fever. Hence I humbly am of opinion, but submit the question to the decision of scholars, that the use of the denomination *variola vaccina* is a transgression of the law in philology, and repugnant to sound logic.

Extended as this paper is, much beyond the limits proposed, I cannot confine to myself the gratification from the reports of the *new inoculation*. I shall only mention, however, one or two of them. The sensation excited on the Continent, by the vaccine practice, has been much more considerable than in our own island, as I learned first from Dr. Marcet, and since by a letter from Dr. Peschier. At Vienna Dr. Ferro inoculated two of his own children with vaccine matter which I transmitted: and next, Dr. De Carro inoculated two of his own children. An accurate journal of these last cases was kept by Dr. De Carro, which he has had the complaisance to communicate to me. The above patients had the disease in the usual mild way, and were subsequently inoculated for the small-pox, but without effect. Dr. Frank, it is expected, will adopt the vaccine inoculation; as it appears will be generally done at Vienna. I often send matter on a thread, which is to be kept for a long time, in a bottle filled with quite dry hydrogen or nitrogen gas. I shall soon have reports from Portugal, and other parts of the Continent.

In Scotland the new inoculation has not been less successful. Dr. Anderson, of Leith, informs me he has inoculated above 80 persons—that Dr. Duncan and others have begun the practice at Edinburgh; and that it has been introduced in Dundee, Paisley, and Dalkeith.

If the vaccine inoculation proceed with equal mildness as it has done the last four months, doubtless the variolous incision must in no remote period be superseded. And if such an event should take place, posterity will behold with amazement the prejudices and inattention of their predecessors to the application of a fact in practice, by which a formidable  
and



and loathsome disease was extinguished—a fact well known, time immemorial, to almost every farmer in half a dozen counties of England, but neglected till Jenner had the courage to indicate the advantages of it to society. If I were to name a parallel instance of inattention or prejudice, it should be the neglect of inoculation for the small-pox, till it was introduced into England from Constantinople; although it had been practised, time immemorial, in the Barozzo mountains, on the frontiers of Gallicia, in the same rude manner as it is at this day\*.

XVIII. *Query respecting the natural Boundaries between Europe and Asia.*

*To the Editor of the Philosophical Magazine.*

SIR,

THE variety of useful geographical communications in your valuable scientific miscellany, encourages me to hope that some of your correspondents may be able to inform me of what many of the geographical publications, to which I have had recourse, give no satisfactory account: it is, What are the boundaries between Europe and Asia? The last edition of the *Encyclopædia Britannica*, to my great surprise, gives nothing but a string of contradictions. Under the article *Oby*, that river is said to form the boundary between Europe and Asia; yet, in the wretched maps given in this expensive work, the range of mountains known by the name of *Oural* is marked as the boundary. Neither are the *Oural* mountains mentioned at all in their proper place; but, under the article *Mountain*, “the *Ouralic* chain is said to form a

\* This intelligence was communicated to me by a Portuguese nobleman, whose opportunities of information and accuracy authorize me to mention the fact, but an attested account from some of the inhabitants is intended for me. See also a book written by *Jacobs à Caçiro Sarmiento*.

natural boundary between Europe and Asia." And in Vol. VII. p. 39, when enumerating the boundaries of Europe, it is said to be "separated from Asia in part by the Archipelago, as also by the Black Sea, then by the river Don till it comes near the river Volga or Wolga, and then it is parted from Asia by this last, and afterwards by the river Oby."

The greatest instance of inaccuracy, however, is when, enumerating the boundaries of Asia, Vol. II. p. 393, it is said to be "separated from Europe by the Mediterranean Sea, the Archipelago, the Black Sea, the Palus Meotis, the Don, and the Dwina, which fall into the White Sea." Such are the contradictions to be met with in that heterogeneous, though in many instances justly celebrated work. The gazetteers of Watson, Salmon, and Brookes, uniformly contradict themselves, describing the river Oby as being the boundary between these two quarters of the world, and their maps representing the chain of Oural mountains as the boundary. It is not so much to be wondered at in gazetteers, which are, generally speaking, catchpenny publications, servilely copying from each other, even their very faults, except Crutwell's lately published, and an excellent little pocket one, Peacock's: it is, however, to be regretted, that the editor of that most useful and excellent geographical grammar, Guthrie's I mean, has also fallen into this error.

If any of your correspondents will inform me how this matter is, it will be considered as a favour by one who has already received much entertainment and information from the Philosophical Magazine.

*August 12, 1799.*

L. M.

P. S. There is a similar mistake to be found in most geographical descriptions of Ireland; the county of Clare being enumerated amongst the counties of Munster, and the map representing it as part of the province of Connaught, which certainly appears its most natural appropriation.

# INTELLIGENCE,

AND

## MISCELLANEOUS ARTICLES.

### MINERALOGICAL SOCIETY OF JENA.

**I**N the public sitting of the Mineralogical Society of Jena, held on the 26th of May at the Ducal Palace, Mr. Bodo, from Hungary, read a paper to prove that organisation cannot be denied to any natural body, and that the division into organised and unorganised is consequently inadmissible. M. Stark, the secretary, read a paper sent in by M. Mihalik, of Dopschau in Hungary, on the following question: Whether mineralogy could exist as a science without the help of chemistry? — Dr. Bonzel proposed, that various minerals now arranged under one general name, should in future, on account of their peculiar marks of difference, be separated in the system, and be distinguished by particular names. Thus, for example, that the red zeolite, from Fassa in the Tyrol, should be called *Fassaite*, to distinguish it from the real Icelandic zeolite; and that the schorl, from Oisans in Dauphiné, should be called *Oisanite*, to distinguish it from that of Thum in Saxony.

### LITERARY NEWS.

That most learned, indefatigable, and amiable cultivator of science, R. Kirwan, Esq. is now in London, where he has been for the last three months. With sincere pleasure we can announce that this revered veteran is printing and preparing for the press three valuable works:—

1. *A Treatise on the Analysis of Mineral Waters*: a most difficult and nice subject, and which will require all Mr. Kirwan's mental powers and knowledge to treat of successfully,

fully. Nothing has been done on this subject since the new system of chemistry has been generally adopted.

2. A Memoir on the interesting and fundamental Part of Chemical Science, the precise Quantities of Menstrua and Bases contained in the double Salts with alkaline, earthy, and metallic Bases: whence may be deduced the precise Forces of the Affinities of Bodies.

3. A work on Geology; which will be made not only to accord with the Mosaic Doctrine, but to confirm it greatly.

Of this philosopher permit us to indulge in the wish—

*Serò in cælum redeat.*

#### NATURAL HISTORY.

The following instance of the sagacity of the elephant, which is taken from a late French Journal, may serve as an additional confirmation of what has been so often repeated by various authors both ancient and modern:—

“ A sentinel belonging to the menagerie at Paris, anxious to discharge his duty, was extremely careful, every time he mounted guard near the elephants, to desire the spectators not to give them any thing to eat. This conduct was not much calculated to procure him any friendship from the elephants. The female, in particular, beheld him with a very unfavourable eye, and had several times endeavoured to correct his unwelcome interference by besprinkling his head with water from her trunk. One day, when a great number of people were collected to view these animals, the opportunity seemed convenient for receiving, unperceived, a small bit of bread; but the rigorous sentinel was on duty. The female, however, placed herself before him, watched all his gestures, and, the moment he opened his mouth to give his usual admonition to the company, discharged in his face a large stream of water. A general laugh ensued; but the sentinel having calmly wiped his face, stood a little to one side, and continued as vigilant as before. Soon after  
he

he found himself under the necessity of repeating his admonition to the spectators not to give the elephants any thing; but no sooner had he done so than the female laid hold of his musket, twirled it round in her trunk, trod it under her feet, and did not restore it until she had twisted it into the form of a screw."

#### INTRODUCTION OF THE CAMEL AT THE CAPE OF GOOD HOPE.

Notwithstanding the great number of travellers who have attempted to penetrate into the interior part of Africa by the way of the Cape of Good Hope, the districts left unexplored are immense when compared to those which have been visited. One of the greatest obstacles to travelling in these wild and parched regions, is the want of proper beasts of burthen; for it is well known that cattle cannot long endure thirst, and that numbers of them employed on that service by travellers have died by the way, and thereby rendered their attempts to proceed farther useless. This fact must be well known to those who have read Vaillant's Travels. Professor Heeren of Gottingen proposes therefore, in order to remove this difficulty, the introduction of the camel at the Cape of Good Hope. "There can be no doubt," says he, "that this animal would thrive there, as the climate is exactly the same as that of the countries where it is now found. It would no doubt succeed as well in the latitude of  $35^{\circ}$  S. as the lat. of  $35^{\circ}$  N. in Syria. The exploring of the interior parts of Africa is not the only advantage which might be derived from the introduction of the camel at the Cape: of what utility would such a beast of burden be to the planters, many of whom live at a great distance from the Cape town, and can at present send their productions thither in no other manner than in waggons drawn by four oxen! The principal point, however, would be the opening a commercial intercourse with the interior part of the country. It cannot be doubted that the southern extremity of Africa is

more productive than the northern, and why might not the Cape be the centre of a trade which in future may become very extensive? But without the assistance of the camel it could never be attempted. The present period is the more favourable for putting this proposal in execution, as the Cape is now in the possession of Great Britain; and even if it should be given up at the next peace, the British government would by this service to the colony raise a monument worthy of its dignity: the expence of transporting a few camels from Mogador would be very trifling.”—We agree in opinion with Professor Heeren, and think his proposal well worth attention.

#### ANIMAL ELECTRICITY.

Dr. Chladni, well known by his discoveries in regard to sound, has lately announced the following observation on animal electricity, which we here give in his own words:

“ It might be conjectured, when electricity manifests itself in animals, that it would be equally diffused throughout the whole body on account of the conducting power of the interior parts; yet we are taught by experience, that the opposite kinds of electricity take place in the torpedo as well as in cats, though in a less degree; and perhaps the case is the same in other animals. Some years ago I remarked that a cat which had been rendered electric by stroking with the dry hand, especially when lying near the fire on dry days in winter, exhibited opposite kinds of electricity; and that the principal seat of the one was in the head, and of the other in the back, about two inches from the tail. This phenomenon appeared above all when the animal was upon a chair stuffed with hair, and covered with a woollen cloth, by which it was completely insulated. When the head, and in particular the tip of the nose, or of one of the ears, was touched by the finger, there appeared a small electric spark; the case was the same when the extremity of the back was touched; and in this manner sparks could be drawn alternately from the anterior and posterior parts of the body in the same man-

ner as sparks can be drawn alternately from an insulated charged jar. I afterwards observed the same thing in another cat; but, as at that time I paid little attention to this part of philosophy, and supposed that the existence of the opposite kinds of electricity in animals might have been known, I made no farther experiments, and could not determine which of these electricities was negative and which positive. I leave it, therefore, to others to examine this phenomenon with more accuracy."

#### METEOROLOGY.

A very singular work was published last year at Liegnitz in Silesia, entitled *Aphorisms respecting the Influence of War on the Atmosphere, Weather and Fertility of the Earth*. Among the author's observations are the following: If a cubic foot of gun-powder, when it explodes, exercises a force equal to twenty-nine millions of pounds, it by these means produces a great change in the elasticity of the air; the whole mass of the atmosphere, within a large circumference, is violently torn, and billows of air are produced, which roll themselves upwards and agitate the vapours contained in them. It cannot therefore be denied that the discharging of fire-arms and cannon during battles and sieges, and even at great reviews, must have an influence on the atmosphere, and on the state of the clouds and weather. He quotes instances in the time of the seven years war, of clouds and vapours being dispersed by the explosions of the cannon; and asserts that, during his travels through the Tyrol, he saw on several occasions, to use his own expression, the clouds "shot dead." He observed in the neighbourhood of Liegnitz, while the regiment of Wartensleben were going through their exercise, that the clouds were broken by the explosions, and that the murmuring of the wind, and the agitation of the leaves of the trees, and the small feathers suspended from any body, were sometimes stronger, sometimes weaker, according as the troops fired by battalions or companies. The barometer

rose and fell at each explosion; and water in a vessel, at the distance of five hundred paces, was violently agitated. There have been instances of the noise of heavy cannonades, in the last and present war, being heard at the distance of more than forty miles. Nay, the thunder of cannon penetrates even into the interior parts of the earth, and to the bottom of the sea, so that whales and herrings have been frightened away to the distance of two hundred miles. The author, from these principles, endeavours to account for certain singularities which prevailed in the weather in some parts of Germany in the year 1797; and to shew that the quantity of gun-powder fired in the time of war may have a sensible effect on the fertility of gardens and fields. In the seven years war above a million of pounds of powder were fired off in Europe; and it may with certainty be affirmed that no less a quantity has been consumed in the present war against the French.

#### NEW BASIS FOR BLACK PAINT.

A most excellent basis for black paint has been discovered in the Lead-mines of Nant Gwider, in the Vale of Conway, by Mr. Goodwin of Llanroost, proprietor of several mines, of which a description and analysis will be given in some future number of the Philosophical Magazine, together with that of several other substances he has discovered in North Wales, and which it is presumed will be of considerable utility.

#### SUGAR FROM THE BEET-ROOT.

Professor Götting, of Jena, has announced a small work, which he intends to publish soon, on the preparation of sugar from the beet-root. The Professor in his prospectus observes, that the various kinds of beet with which he made experiments, must be treated in a quite different manner from the sugar-cane, or the method employed by Margraaf, in order to obtain from them good sugar. In regard to the quantity of sugar which they produce, he found very little variation.



tion. Some have said that 100 pounds of roots are sufficient for eight pounds of sugar; but Professor Götting could obtain from 100 pounds of roots no more than two pounds and a half. As the Professor has promised to give a full account of the process in his pamphlet, it will no doubt be interesting to those who wish to make experiments on this subject.

#### SIZE MADE OF POTATOES.

One of the beneficial uses of potatoes, not perhaps generally known, is, that the starch of them, quite fresh, and washed only once, may be employed to make size, which, mixed with chalk, and diluted in a little water, forms a very beautiful and good white for ceilings. This size has no smell; while animal size, which putrefies so readily, always exhales a very disagreeable odour. That of potatoes, as it is very little subject to putrefaction, appears from experience to be more durable in tenacity and whiteness; and for white-washing should be preferred to animal size, the decomposition of which is always accompanied with unhealthful exhalations.

#### DEATHS.

On the 29th of April, at Leyden, David Van Royen, Professor of Botany in that University, in the 70th year of his age.

On the 7th of this month, at his house in Newman-street, John Bacon, Esq. R. A. the well-known sculptor. He was a native of Southwark, and, when a child, distinguished himself by moulding figures in clay, and very early in life obtained prizes from the Academy.

On Thursday the 22d instant, in the 49th year of his age, Mr. Benjamin Thomas Pouncy, engraver; an artist of the first eminence in his profession. He was the brother-in-law and most distinguished of the disciples of Woollett, with whose vigour and richness of style he has with peculiar felicity united the freedom and simplicity of Vivares; “and,  
with

with a master's hand and poet's fire," has secured to himself the praise of originality, by blending both with his own view of Nature. To enumerate his engravings, and comment on them in the detail, would be more than the present disposal of the writer's time will permit; yet the mention of a few of their leading traits is at least due to the merits and the memory of so excellent an artist. Freedom, boldness, and an happy imitation of the wild forms of inartificial Nature are among their distinguishing features. The drawing of his trees in particular; his discrimination of their several characters; his thorough knowledge of their various modes of growth, combined with a mode of expression arising spontaneously out of his subject, have perhaps never been excelled. Among the rude and artless landscapes of the South-sea islands, or the wild and luxuriant forms of lake and forest scenery, his etching-tool and his fancy would revel delighted, and communicate to every cultivated eye a corresponding pleasure. With such claims to superior art, men of discernment will lament that it was the lot of Pouncy to be obliged to trammel his talents, and employ a considerable portion of his time in engraving *fac-similes* from the pages of Doomsday-book; in tracing the Spanish lines before Gibraltar; and on other subjects that required merely care, and the exercise of a certain regular mathematical ability he did not naturally possess. On the whole, it may be said of his works, which are chiefly after Farington, Hearne, Smith, and Wilson, that they will continue to be admired wherever legitimate art and true taste are not obscured by the false glitter so much the fashion of the day; and that, in private life, the hospitality of his manners, the compass of his knowledge, the liberality of his sentiments, and the goodness of his heart, will long be remembered with regret by those who had the happiness of being intimately known to him.

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PHILOSOPHICAL MAGAZINE.

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- I. *On the gradual Changes in Temperature and Soil which take place in different Climates, with an Enquiry into the Cause of those Changes. By the Abbé MANN\*.*

**V**ARIOUS authors, both ancient and modern, have written on the subject of this Dissertation, but merely in a cursory manner; one only, Dr. Hugh Williamson, an American physician, has made it an object of particular attention; but what he has said relates only to North America, and is comprehended in a very short paper published in the Philosophical Transactions of Philadelphia for 1777. It has long appeared to me interesting enough to require farther and more accurate examination; but before I enter into any research respecting the causes of those changes of temperature and soil, observed in different countries during a long series of ages, it seems to be necessary first to prove, by authentic testimony, that these changes have actually taken place. This Dissertation divides itself naturally into two parts. In the first I shall collect all the information of an-

\* From the *Transactions of the Electoral Academy of Sciences at Mannheim*, Vol. VI.

cient authors I have been able to find on the state of the temperature and soil in their time in Gaul, Germany, Pannonia, Thrace, Mœsia, Iacica, and the European part of Scythia. As most of these writers, however, when they speak of the climate of those countries, express themselves more or less in an almost unintelligible manner, and nearly in the same words, it would be superfluous to quote, at full length, all the passages I have collected on the subject. I shall therefore content myself with giving, in regular order, the substance of all the circumstances they have communicated to us in regard to the climate of the above countries; and in the second part I shall briefly enquire into the physical causes which, in the course of several centuries, may have gradually contributed to produce these changes.

*I. Proofs of the Change of Temperature and Soil in the  
Climates of Europe.*

We are told by Herodotus, more than once, that in the European part of Scythia, on the Palus Meotis, the winter continued eight months every year with almost insupportable severity; and that the countries farther towards the north were on that account uninhabitable: he adds, that the other four months, called the summer, were also exceedingly cold. Now this country lies between the 44th and 50th degree of north latitude, and we know at present that nothing of the like kind has taken place there for a long time. Cæsar, Virgil, Diodorus Siculus, Ovid, Strabo, Pomponius Mela, Seneca, Petronius, Pliny the naturalist, Statius, Herodian, and Justin, all speak in the same manner of the insupportable cold of the winter in different parts lying in the same latitude of from 44 to 50 degrees between Gaul and the Euxine Sea. They quote so many and so evident effects of this winter cold, that it is not possible to ascribe their descriptions to the manner of life they were accustomed to in the warmer districts of Italy, Greece, or Asia.

The descriptions which they unanimously give, would at  
present

present suit those countries which lie between 56 degrees of latitude and the polar circle; and in some respects they seem to exceed the cold of the winter in Sweden and Norway. In order to see realised at present the descriptions which the ancients have given of the climate of the middle part of Europe in their time, it would be necessary to visit Lapland, Siberia, and those regions of America lying to the north of Hudson's Bay, where the state of the climate is the same as that 2000 years ago on the banks of the Rhine and the Danube, the Palus Meotis, the Dnieper, and the Don.

The first effect, uniformly mentioned by the ancients, of the extraordinary cold of the winter in that whole part of Europe between the 44th and 50th degree of latitude is, that all the seas, lakes and rivers contained in those districts were continually frozen in winter, so that armies of barbarians, Scythians and Sarmatians, in order that they might plunder the more southern countries, passed with their horses, waggons and baggage over the ice, which they bestrewed with straw to prevent their sliding. This is expressly asserted by Herodotus, Virgil, Ovid, and Strabo, of the European part of Scythia, Dacia, and Thrace, all countries which lay in a northern and western direction from the Palus Meotis and the Euxine Sea. The same thing is asserted by Diodorus Siculus, Seneca, Pliny the younger, Florus, Herodian, Ammianus Marcellinus, Fernandes the Goth, and Xiphilinus the abridger of Dio Cassius, in regard to the rivers and lakes of Pannonia, Germany, and Gaul. They mark the times when these armies passed the ice, and the wars which they then carried on; so that no doubt can be entertained in regard to testimony so unanimous and authentic. Herodotus says, that the Scythians in this manner over-ran, during winter, all the neighbouring countries as far as India; and we are told by Strabo, that Neoptolemus, the general of Mithridates, beat the barbarians in winter with an army of cavalry, at a place which in summer had been the scene of a naval battle. In the *Treatise on Rivers*,

ascribed to Plutarch, it is said, the Thermodon, a Scythian river, froze even in summer; a circumstance which never happens at present in regard to the rivers of Siberia, Lapland, and Greenland. Ovid tells us, that he himself passed over the Pontus Euxinus on the ice. People, adds he, will scarcely believe me:

————— Sed cum sint praemia falsi

Nulla, ratam testis debet habere fidem.

Plutarch says, that the pressure of this enormous mass of ice against the sides of ships frozen into it, crushed them to pieces; and he mentions the instance of a Roman ship which had experienced that fate in the Danube. Strabo and Virgil speak of brass vessels bursting by the expansive force of the ice; and we are assured by Virgil and Ovid, that the people in Thrace and on the Danube cut the wine with axes, and distributed it in solid portions. They add, likewise, that men's hair and beards were often covered with ice.

Stiriaque impexis inducent horrida barbis.

VIRGIL.

Sæpe sonant moti glacie pendente capilli,

Et nitet induscto candida barba gelu.

OVID.

If we compare this description with the present state of France, Germany, Hungary, Romania, Transylvania, Wallachia, Moldavia, Bulgaria, Lesser Tartary, Podolia, and the Ukraine, it will be found that the present temperature of these countries has no resemblance to what it was two thousand years ago: the effects produced there every winter scarcely take place now once in a century, and when they occur they are considered as extraordinary phenomena.

From ice I shall proceed to snow. Herodotus, Pomponius Mela, and Pliny the elder, speak of the European part of Scythia as if its atmosphere was continually filled with snow and fogs, which prevented the view of the nearest objects, and obscured the light of the day. We are told by Herodotus, that this immense load of snow, when it fell, made the air appear as if filled with feathers; and that, for  
this

this reason, the country was called *Pterophoros*. Diodorus Siculus speaks of Celto-Scythia as covered with snow in the winter time; and the same thing is asserted by Florus and Petronius. Virgil, speaking of Thrace and the countries on both sides of the Danube, says, that a continual winter prevailed in them; and that the snow lay upon the ground sometimes to the depth of seven ells.

Sic jacet aggeribus niveis informis, et alto  
Terra gelu latè, septemque assurgit in ulnas,  
Semper hyems, semper spirantes frigora cauri.

The picture which Ovid gives of the snow at Tomi (in the lat. of  $44\frac{1}{2}$ ) is no less horrid, as he tells us that it continued two years without being melted by the sun or rain:

Nix jacet et jactam nec sol pluvixque resolvunt;  
Et solet in multis bima manere locis.

In regard to other meteorological phenomena in the European part of Scythia and Celto-Scythia in the time of Herodotus and the following century, this historian says, that it seldom rained in the winter, because at that period it seldom ceased to snow; and that, on the other hand, when the weather in summer was dry and fair in Greece and Lesser Asia, it never ceased to rain in the country of the Celto-Scythians: that during this season the heavens were always overcast with clouds, and that thunder, even in summer, was very uncommon; that when it happened in winter, it was considered as a wonder, and that, in those seasons when it took place, earthquakes were observed also. This last circumstance is indeed worthy of attention, as it serves to confirm my conjectures respecting the theory of the earth.

Diodorus Siculus, Tacitus, and Ovid, when they speak of Gaul, Germany, and Thrace, take notice of the prodigious force of the wind which prevailed in these countries in their time and during the preceding centuries. These winds raised even stones and men from the earth; carried away the roofs of houses; tore up trees by the roots, and overturned turrets

and houses. Such effects of the wind are indeed observed at present, particularly in the countries on the Northern Sea and the Bay of Biscay, but seldom in those parts of the Continent spoken of by the ancients.

Varro, Diodorus Siculus, Ovid, Pomponius Mela, Seneca, Petronius, Pliny the elder, Tacitus, Appian, Dio Cassius, and Herodian, all agree in saying that the severity of the climate and weather which in their time prevailed in Gaul, Germany, Pannonia, Thrace, Mæsia, and Dacia, would hardly admit either vines, olives, or any kind of fruit-trees; and that, in cultivating them, it was necessary to cover them with dung or with earth to preserve them throughout the winter. Tacitus, however, adds, that these countries produced, in abundance, various kinds of grain, where the people gave themselves the trouble to improve and manure their fields by means of marl or chalk, which destroyed the cold and the moisture. This circumstance is expressly remarked by Varro: *Agros stercorearent candida fossilia creta*. He afterwards adds, that in these countries there was neither rock salt nor sea salt: the preparation of the latter required a stronger heat than existed in those climates \*. The inhabitants supplied the want of salt by saline ashes from certain kinds of wood burnt for that purpose, and which were drenched with salt water. Pliny and Tacitus give the same account.

It is observed by Herodotus, Strabo, and Tacitus, that the oxen in the European part of Scythia and the country of the Celto-Scythians had no horns, or horns exceedingly small; which they ascribed to the severity of the cold and the climate. Herodotus confirms this idea in a negative

\* This, indeed, proves nothing in regard to the climate; but it shews the want of knowledge and industry. The passage in Varro *De Re Rustica*, i. 7. is as follows: *Ubi salern nec fossitium nec maritimum haberent; sed ex quibusdam lignis carbonibus salis pro eo uterentur*. It is probable that they boiled their salt, as was done in former times in some parts of Europe; that is, poured the saline liquor over glowing pieces of wood, and collected the salt which adhered to the charcoal. G.



manner by the testimony of Homer, who says in the *Odyssæy*, that in Lybia the lambs had horns from their birth, owing to the great heat. Strabo, as a proof of the great cold which prevailed in the country now called the Ukraine, observes that it produced no ass's; animals, says he, which cannot endure the cold: and he adds, that the horses there were extremely small. But nothing, indeed, is more astonishing than the testimony of Pausanias, who says expressly, that in Thrace there were in his time bears and wild swine of a white colour. Such animals at present are found only in the remotest parts of the north, on the other side of the polar circle. We are told by Virgil, Ovid, and Pomponius Mela, that the inhabitants of the European part of Scythia and Thrace lived, during the whole winter, under the earth (as the Laplanders do at present); that they burnt large logs of wood to keep themselves warm; that they never went abroad without being wrapped up in skins; and that they left no part of the body uncovered but the mouth and eyes. Pomponius Mela says, *Specus aut suffossa habitant, totum braccati corpus, et nisi qua vident etiam ora vestiti.*

I think it of importance to point out here the boundaries of those countries towards the north, which the ancients considered as desolate and uninhabitable on account of the great intensity of the cold. Herodotus says, that beyond the Melanchlini, a Sarmatian people, so called from their black hair, there were only lakes, morasses, and uninhabitable districts as far as was then known; and we learn from Ovid that on the other side of the Cimmerian Bosphorus, the Tanais, and the Scythian morasses, a cold prevailed which rendered the country uninhabitable.

Bosphorus et Tanais superant Scythique paludes;

Uterius nihil est, nisi non habitabile fugus.

This is expressly confirmed by geographers and historians. Strabo repeats, several times, that all the lands towards the north of the tribes who lived on the banks of the Tanais

and the Borysthenes were uninhabitable on account of the severity of the cold which prevailed in them. But all that has been traced out of the banks, and even the origin of this river, does not lie beyond the 55th degree of latitude; consequently is on the same parallel with the northern part of England and Germany, the middle of Lithuania, and the middle of Russia. Between these two rivers Strabo places also the Rhoxolani, who in general are considered as the ancestors of the Russians; and he adds, that all the districts farther north were uninhabitable on account of the cold. In another place he says, that all the northern part of Britain was very thinly peopled on account of the cold, and that he believed all the countries lying beyond it to be uninhabited. Now no part of Great Britain extends beyond the 60th degree of north latitude; consequently that parallel includes all Norway, almost the whole of Sweden, and the half of Russia. These countries, therefore, in the time of Strabo, that is, about the period of Augustus, were considered as uninhabited. The ancients, in general, speak of all the lands which lay beyond the 55th degree of north latitude as filled with lakes, morasses, ice, snow, and fogs, almost like those countries to the north of Hudson's Bay.

These, in my opinion, are sufficient and unquestionable proofs of the excessive severity which prevailed 2000 years ago in the climate of those countries of Europe lying between the latitude of  $44^{\circ}$  and  $50^{\circ}$  north latitude, and fully establish the difference between the state of their temperature in those periods and what it is at present. The more northern lands, which the ancients, on account of their unsupportable cold, considered as uninhabitable; Iceland, Norway, Lapland, and the northern part of Russia and Siberia, are habitable, and inhabited at present, as is well known, though exceedingly cold. The ancients also speak of effects produced by the cold of winter in Italy, Greece, Lesser Asia, &c. which at present are certainly unknown. The soil of the latter countries, as well as that of the ancient Assyria, Chaldea, Palestine,

Palestine, the Roman part of Africa, and Spain, is at present remarkably stony, and burnt up with heat. We, however, know, that Spain in particular, about 1800 years ago, was exceedingly rich and fruitful, and abounded with all sorts of provisions, which are no longer to be found in it \*. It appears to me unnecessary to produce more proofs, as the change of the soil and fertility in all the countries bordering on the Mediterranean Sea, and which formed the richest and most beautiful part of the Roman empire, is admitted as a certain fact by all those who have spoken of their former and present state.

It is therefore beyond a doubt, that the soil and temperature of all the lands from Spain to India, and from the ridge of Mount Atlas to Lapland and the remote parts of the north, have in the course of ages, since the period of the oldest historical monuments still extant to the present time, been gradually subjected to a complete change, from the utmost degree of moisture and cold, to a great degree of dryness and warmth. An effect so continued and uniform must have some cause, which is equally so itself.

Dr. Williamson asserts, that the climate of America is becoming continually milder; and he confirms it by a number of facts. This effect is directly contrary to the hypothesis of a celebrated naturalist respecting the theory of the earth and the planets, who asserts, that they have been continually losing warmth since they were first in a state of fusion, and are becoming always colder; so that they will at length be incapable of keeping alive any animal or vegetable production †. All historical and physical monuments, however, prove the contrary.

\* The districts in the neighbourhood of Toledo are destitute of trees, on which account the heat in summer is unsupportable, and wood in winter exceedingly dear. When Martial wrote the following lines, the country must certainly have been in a very different state :

*Ætas serenus aureo franges Tago  
Obscurus umbris arborum.*

† This was the opinion of Buffon. *ELT*.

It is not merely in modern times, and since the improvement of natural philosophy, that this change of temperature and soil has been remarked. A great number of places, well known and described by the ancients, in Palestine, Syria, Lesser Asia, Greece, Italy, Spain, and Barbary, exhibit proofs of the changes which have taken place in the soil and temperature in the course of time. Every one knows their present dry and barren state, which seems to be past remedy. It is so contrary to that in which they were formerly, according to all the descriptions of them left us by Greek and Roman authors, that it is impossible for us to ascribe this difference merely to the inclination of the ancients for exaggeration \*: the clear and precise facts, which various celebrated authors have mentioned respecting them, will not allow of so absurd a supposition. Ovid says that, in his time, Lower Mœsia, to which he was banished, produced neither vines nor fruit-trees,

Nam procul à Getico littore vitis,

Nam procul à Geticis finibus arbor abest.

Strabo, who was a few years later than Ovid, speaking of vine plants in the Thracian Bosphorus, says, that in winter it was necessary to bury them under the earth in order to preserve them. Not long after, it was observed by Pomponius Mela and Pliny the elder, in speaking of Thrace, that there were scarcely any fruit-trees in that country, and that in winter it was necessary to cover them with dung. Mela adds, that the vines often grew there, but that the grapes never ripened †. Columella is the first author who speaks of vines in Gaul; and he says that the Sabines and the Romans in the preceding century had procured, amidst the devastation of war, more abundant crops than had been procured in his time during a state of perfect peace. But no-

\* Voltaire pays this compliment to the authors of the Bible in regard to Palestine.

† Vitam frequentius tolerat, sed nec ejus quidem fructus maturat ac mitigat.

thing in this respect is more striking than what is observed by Columella in regard to the changes of climate. "I find," says he, "that it is the opinion of many respectable authors that the quality and state of the atmosphere become changed in the course of a long series of ages: for Salserna, in that work which he has left on agriculture, infers that the state of the atmosphere is changed, because certain districts, which formerly were incapable of producing vines or olives on account of the continual severity of the winter, now yield abundant vintages and plenty of oil by the climate having become milder and warmer\*." But it is now time that I should proceed to an inquiry into the causes that produce these changes, the effects of which I flatter myself I shall be able to prove.

[To be concluded in next Number.]

## II. Observations on the Vibration Nodes of Musical Strings.

By J. G. VOIGT of Halle†.

**EXPER. I.** Divide AB, the string of a monochord, into any number of equal parts, for example four, by the points CDE, and place a moveable bridge at E; put on the points C, D of the string, and any others at pleasure, light bodies, such as small bits of paper, and draw a violin bow, rubbed with rosin, over the part EA; you will hear the tone corresponding to the part EA, which is to the tone of the whole string AB as 4:1; and all the bits of paper, except those lying on the points

A. — C — D — E — B

\* Multos enim memorabiles auctores comperi persuasum habere, longo ævi situ qualitatem cœli statumque mutari ———. Nam (Salserna) eo libro quem de agriculturâ scriptum reliquit, mutatum cœli statum sic colligit, quod, quæ regiones antea propter hiemis assiduam violentiam nullam stirpem vitis aut olæ depositam custodire potuerint, nunc mitigato jam et intepescente pristino frigore largissimis olivitatibus, liberique vindemiis exuberent. *De Re Rustica*, Lib. i. cap. 1.

† From Gren's *Journal der Physik*, Vol. II. part 3.

C and D, will, by the vibration of the string, be thrown from it. The points C and D are called vibration nodes. In this, and all the other experiments of this kind, the point where the bridge stands is also a vibration node.

II. Divide the string AB into a number of equal parts at pleasure, for example five; cut off, by removing the bridge to E, two of these parts (this number 2 and the other 5 must have 1 for a common divisor); place upon the points of division C, D, F, and any others of the string taken at pleasure, light bodies, such as bits of paper; draw the violin bow over the part EA, and all the bits of paper except those on C and D will then be thrown off, and you will hear a tone which is to the tone of the whole string as 5 : 2, and which corresponds to the tone of the part EA.

III. Divide a string AB into any number of equal parts, for example six, by the points C, D, E, F, G; cut off as before, by removing the bridge to F, two parts (this number 2, and 6 the number of the parts of the whole string, must have a greater common divisor than 1); place upon the other four points of division C, D, E, G, and on any others of the string taken at pleasure, light bodies, such as bits of paper; and all these, except that at D, will be thrown down by rubbing the bow against FB, the part cut off by the bridge; you will also hear a tone corresponding to the part FB, which is to the tone of the whole string as 6 : 2 or 3 : 1.

IV. If you place upon the string, without cutting off any part of it by the bridge, different bits of paper in points taken at pleasure, and rub with the bow so as to make the whole string sound, all the bits of paper will be thrown from it. This experiment will give the same result when you cut off in the middle the part of the string which actually sounds; for example, you may vary the second experiment thus:—

V. Divide the string AB by the points C, D, E, F, into five equal parts; cut off, by means of two moveable bridges, the part DE; place upon C and F, and other points of the string AB, small bits of paper: rub the bow against ED; all the bits of paper A.—.—.—.—.B will be thrown off except those in C and F, and you will hear the tone corresponding to DE, which is to the tone of the whole string as 5 : 1.

From these few experiments, the following laws respecting vibration nodes may be deduced:—

1. The part of the string apparently at rest is not perfectly so, but only its vibration nodes.

2. The original vibrating part of the string, which is brought into immediate vibration by rubbing with the violin bow, has no vibration nodes; and therefore no string on the violin, violoncello, harp, or harpsichord, can have any. All the vibration nodes on these instruments lie behind the bridge.

3. For vibration nodes to be possible, a part of the string must be apparently at rest; consequently, the number which expresses the height of the tone emitted, as compared with the tone of the whole string = 1, must be greater than one, and must therefore be expressed by an improper fraction.

4. In order to determine the number of the vibration nodes of a string for the tone  $\frac{a}{b}$ , where, as before shewn,  $a$  must be greater than  $b$ , we need only reduce the fraction  $\frac{a}{b}$ , which expresses the proportional height of the tone, to its lowest terms  $\frac{p}{q}$ , and subtract the smaller number  $q$  from the greater  $p$ : the difference  $p - q$  will be the number of the vibration nodes. This law follows very naturally from the preceding experiments.

When the height of the tone to be produced is to the tone of

of the whole string as  $\frac{a}{b}$ ,  $\frac{b}{a}$  parts of the string must be rubbed with the bow in order to produce that tone, that is, the string is divided into  $a$  parts, and  $b$  parts must be cut off and rubbed with the bow; therefore  $a-b$  are parts of the string, or  $\frac{a-b}{a}$  of the whole string apparently at rest, the extreme points of which are capable of producing vibration nodes; and when  $\frac{b}{a}$  is brought to its lowest expression, it gives  $a-b$  vibration nodes. If  $\frac{b}{a}$  be not in its lowest terms, let its lowest terms be  $\frac{q}{p}$ ; so that  $\frac{b}{a} = \frac{q}{p}$ , and when  $e$  is the greatest common divisor of  $a$  and  $b$ ,  $a$  will be  $= ep$ , and  $b = eq$ ; therefore  $a-b = e(p-q)$ . Now, if it should be required to apply this law to  $\frac{b}{a}$ , the number of the vibration nodes  $a-b$  must be  $= e(p-q)$ ; but if applied to  $\frac{q}{p}$ , as above demonstrated, the number of the vibration nodes will be  $p-q$ ; therefore  $e(p-q) = p-q$ , which can no otherwise be true than when  $e$  is  $= 1$ , that is,  $\frac{b}{a}$  or  $\frac{a}{b}$  must be expressed in its lowest terms.

5. As the members of two fractions not of the same value may have the same difference as  $\frac{3}{7}$  and  $\frac{1}{5}$ , the same number of vibration nodes may exist where the tones are different, and therefore each tone has not its own peculiar number of vibration nodes.

6. Vibration nodes are only possible where the tones have a certain ratio to the fundamental tone.

It must not, however, be expected, that the experiment can be made, for example, with a string 26 inches in length, in such a manner that you can divide it into 40 or 50 parts, and rub one of them with the bow; for in this case the vibration nodes, or points at rest, are at so little distance from  
each



each other that a piece of paper will cover more than one vibration node, and will be thrown off by rubbing with the bow, though they ought to remain ; or the vibration will be too weak, and not be sufficient to throw off the bits of paper which ought to fall.

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III. *Agenda, or a Collection of Observations and Researches the Results of which may serve as the Foundation for a Theory of the Earth.* By M. DE SAUSSURE.

[Continued from page 265.]

CHAP. XIX.

*Researches to be made in regard to Earthquakes.*

1. **T**HE historical part: the greatness, extent, and chronology of their ravages in different countries.

2. Does it appear that some countries are more exposed to them than others ; are there some absolutely exempted ; and how far is this connected with the local situation of the country ?

3. To observe the extent, duration, and direction of the vibrations experienced by the earth when it shakes.

4. Are there any meteorological phenomena that announce or accompany earthquakes ; such as extraordinary heat, calms, storms, movements of the barometer, electricity, vapours dispersed throughout the atmosphere, paleness or peculiar colour of the sun and stars ?

5. Other phenomena ; such as subterranean noise, extraordinary movement of the sea, the water of springs increased or dried up, any particular smell, symptoms of terror among domestic animals.

6. Are there any indications that some earthquakes may have been the effects of electricity, and that such convulsions might be prevented by conductors ?

7. Are there not some also which immediately depend on  
subterranean

subterranean fires; and which are preceded by or accompanied with volcanic eruptions?

8. Are there any which exhibit indications of the effects of water converted into steam?

9. To ascertain the simultaneous or at least astonishing rapidity of the effects of earthquakes at very great distances.

10. Are there any instances that, during the moment of an earthquake, some pretty considerable tract of land, or a mountain, has been raised to a great height above its former level, and has afterwards remained in a state of elevation?

11. Are there dry fogs, such as that of 1783, which may be considered as vapours, that have issued from the earth by the action of shocks or concussions.

#### CHAP. XX.

##### *Observations to be made on Mines of Metal, Coal, and Salt.*

1. The historical part: the epoch of the discovery of a mine; of its being first worked; the expence and net produce at different periods. If there ever was, or still is, a grant of it, and on what conditions.

1. A. In regard to the physical part, care must be taken to examine whether the ore be in veins or strata; that is to say, whether it intersects the strata of the mountain, or be parallel to them.

2. In mines which consist of veins, the dimensions, thickness, and length of the veins are to be examined; their inclination in regard to the horizon, and their direction in regard to the cardinal points. The miners call this direction the *bours*.

3. The metal it contains; the mineralising substance, and the kind of mineral which thence results.

4. The matrix, or non-metallic fossil, found mixed with the ore.

5. The nature of the soil at the bottom, or that part of the mountain on which the vein rests; nature of the covering, or part of the mountain immediately above it.

6. Nature

6. Nature of the covering of the veins, or those parts of the vein next to the substance of the mountain.

7. Nature of the *druses*, or crystallised *geodes* contained in the vein.

7. A. The form, dimensions, and nature of the mountain which contains the vein.

8. Situation of the vein in regard to the strata of the mountain; under what angle it intersects them.

9. Its situation in regard to the exterior part of the mountain; whether it be parallel to the external inclination of the mountain, or whether that inclination be in a contrary direction.

10. The progress of the vein: whether it be subject to change its direction or situation, and according to what laws; if there are any indications that precede these changes; any corners, vacuities, or fissures, which interrupt the course of the vein; and how it is found after having been lost: situation and distance of the place where it is richest.

11. Lateral veins or ramifications of the principal vein; veins by which it is accompanied, or which run parallel to it.

12. To verify Werner's theory in regard to veins, the fundamental principles of which are as follows:—

A. That the spaces occupied by veins have been originally empty crevices or fissures.

B. That these fissures have been afterwards filled from the bottom upwards, at a time when the sea still covered the mountains; and by the precipitation or crystallisation of the substances which were before dissolved in the waters of the sea.

C. That of two veins crossing each other, the most modern is that which intersects the other.

D. That of two veins, one of which stops and diverts the course of the other, the most modern is the latter.

E. That, in the same vein, the parts nearest to the sides of the surrounding substance, the *salbande* for instance, are the most ancient; those in the middle the most modern; and the intermediate ones of a mean antiquity.

F. Also that, in the same vein, the lowest parts are the most ancient.

G. That in some veins there are found rolled pebbles; in others the remains of organised bodies, shells, and wood; and in others, of coal, stones, and sea-salt.

H. That one may assign the relative age of the formation of different minerals; for example, that tin mines may be said to be of the most ancient formation; then those of uranite, bismuth, &c.

The greater part of the following questions will furnish confirmations of this theory, or objections against it, according to the solution given of them:

13. Is it true that there are mountains, or portions of mountains, so pierced with cotemporary veins that they could not have supported themselves, had not the substance with which they are filled been created at the same time as the mountain itself? I have used the expression cotemporary, because, if we can suppose that the fissures filled by these veins were formed in succession, the objection which this fact would present to the theory of Werner would be by these means resolved.

13. A. I must here repeat the 10th question of Chap. II. How can it be conceived that all the metals and substances found in a vein should have been dissolved by the water of the sea\*?

14. Is it true that there are in Derbyshire vertical veins of lead intersected several times by horizontal strata of amygdaloides or loadstone?

15. Are there found, in the neighbourhood of veins, strata of the same mineral contained in these veins, and which seem to have been deposited at the same time when the deposits of the sea filled the fissures occupied by these veins?

16. Is it well ascertained that there are certain metals and certain kinds of ore found only in certain kinds of moun-

\* Or in the waters of the great ocean, which are supposed to have covered the whole globe of the earth. C.

tains? And, if this circumstance be true, does it arise from the relative age of these minerals and mountains, or from the substance of the mountains favouring the precipitation of one kind of mineral more than that of another?

17. Is it true, as M. de Trebra says, that the richest veins, and the richest points of any vein, are found in the vertical line which corresponds with the lowest part of the reservoirs of the rain water, and never in the peaks and most elevated ridges? And, if this be well ascertained, would it not prove that the veins had an origin posterior to the grand revolutions which have given to the surface of our globe its present form, and that the metals have been deposited in them by the meteoric waters?

18. Is it true also that the richest mines are found in mountains, the declivities of which are not steep\*?

19. Are there instances of veins, entirely exhausted, being again filled up with ore?

20. Does the production of metals depend on the influence of the sun and climate? Are they more frequently found near the eastern or southern, than the western or northern faces of mountains?

21. Can we generalise the observation made in Siberia, Transylvania, at Mount Rose, and in other places, that in gold mines the veins are richer near the surface of mountains than at a greater depth.

21. A. Is it generally true, that the veins are richer at their points of intersection than in any other place?

22. Is the inclination of veins seen more frequently contrary, than parallel to, the adjacent face of the mountain?

23. Does it sometimes happen that the rock which forms the sides (*neben-gestein*) of the vein is as rich and even richer in metal than the vein itself; and would it thence

\* As the Saxon authors generally say; because the fact is true among them and in some other countries, while the case is not so elsewhere, and particularly in the Pyrenees. C.

follow, that the metal arrives at the vein by filtering itself through these sides?

24. Is it true that, in mountains of granite, the grain of the granite is finer and the stone more tender in the neighbourhood of a vein?

25. Are there observed in any mine proofs that subterranean fires have contributed to its formation by subliming the metallic substances, or by melting them? In a word, are there seen there any traces of the action of fire?

26. In the greater part of mines do we not, on the contrary, observe proofs of the action of water in the situation of minerals and of their matrices; in their *druses* (groups of crystals), and in the state, form and nature of their crystallisation?

27. Does there prevail, at the bottom of mines, a heat superior to the mean temperature of the earth? And if such a heat exists in any mine, may it not be explained by that produced by the lamps; by the miners themselves; by some accumulations of pyrites, or some local reservoirs of water, without having recourse to a general cause or central fire?

28. Is it certain that, in general, veins decrease in thickness in proportion as they proceed to a greater depth, and terminate in such a manner that the fissures which contain them are closed at the bottom? Were this fact established, would it destroy the possibility of sublimations arising from the interior parts of the earth\*?

29. In mines which proceed by strata, to observe their nature, extent, thickness, inclination, and depth; their interruption by the veins that intersect them; their alternate swellings and constrictions, as well as the augmentation and diminution of their richness, and the signs which precede these changes.

\* 28. A. Do there exist veins of from ten to twenty fathoms and more in thickness? or have not metalliferous banks or fissures between two different kinds of stone been taken for veins? C.

30. Whe-

30. Whether it be rare to find, under the form of strata, other metallic mines than those of copper, iron, lead, calamine, and manganese.

31. Whether the mines in strata are generally poor near the surface of the mountain, and become richer the deeper they proceed.

31. A. Whether mines, where the metal is found in lumps or in a mass (*stockwerke*), ought to be classed among those in veins or those in strata \*?

32. In coal mines to observe the nature of the coal; more or less compact; more or less rich in bitumen; more or less mixed with argil or pyrites.

33. To examine, in the coal, the traces of their origin; whether they have been formed of wood, turf, or marine plants †.

34. To observe whether there are found the remains of marine or terrestrial animals.

35. The progress of the strata: whether it be true that they often begin by descending in order to become horizontal, and afterwards to re-ascend; and that they are thickest in the horizontal part, and give coal of a better quality ‡.

\* 31. B. To observe also a third position of the ore, or ore found in the transitions (*Stein-scheidung*); that is to say, between two kinds of stone of a very different nature; as between argillaceous schist and calcareous stone, between the same schist and compound rocks, &c. Not to confound this position of ore with real veins, nor with metalliferous banks, ore in strata, and the *stockwerke*. C.

† 33. A. To distinguish carefully real coal from jet or fossil coal (the *braun-koble* of the Germans), and from coal earth, as well as from that substance known by the Germans under the name of *blend-koble*. C.

33. B. To examine whether there is not found sometimes in calcareous soil, fat, gelatinous coal; or whether there is never found but dry, friable coal. C.

‡ 35. A. To ascertain whether there exists fossil coal in veins, as is said to be the case at Wehrau in Upper Lusatia. C.

36. Whether there are several strata, one above the other, with banks or other fossils interposed. The quality and relation of these strata.

37. The nature and thickness of the strata of the earth or stones under which the coal mine is found; the impressions and other vestiges of organised bodies found in these strata.

37. A. How can those who ascribe the origin of coal to forests buried in the earth, explain the very thin strata of that fossil contained between banks of calcareous stones, and which are repeated at different heights in the same mountain? Does not this observation shew that there are coals which have originated also from fuci, algæ, and other marine plants?

37. B. Ought we to suppose that all coals have been in a state of solution? What is the agent which dissolved them, and which may be called the mineraliser?

38. Though mines of rock salt are commonly found in strata, yet M. Fichtel affirms, that there are found in Transylvania enormous masses of pure salt, compact, and without any appearance of foreign bodies. These he considers as of very ancient formation, and distinguishes them from those which are in strata between beds of argil and free-stone mixed with shells. These important facts deserve to be thoroughly examined.

39. To ascertain the truth of an assertion made by the same geologist, that these masses of salt are surrounded by ancient volcanoes; and to determine whether we ought to believe with him, that this salt has been crystallised by the heat of those volcanoes which evaporated the water that held them in solution.

40. To examine, in the last place, whether any of these masses of salt appear to have been raised up by subterranean fires to a height greater than that at which they were at the time of their formation.



41. To examine the reason of the singular connection observed between mines of salt or salt springs and mountains of gypsum \*.

[To be continued.]

IV. *Account of a large Tree in India.* By Colonel  
IRONSIDE †.

BY the side of the Ganges, about three miles above the fortrefs of Allahabad, near the small pagoda of a gossier (*fakir*), I saw, on the 21st of November 1777, four trees called *kulberich*; the trunk of one of which appeared of so uncommon a size, that I sent for a string to measure its dimensions, and found the circumference of it to be thirty feet ten inches. Its height is that of a pretty large beech, the rind or bark even, annulated and pulpy; and all the limbs smooth and very large, but rather scant of foliage; those very small branches which bore leaves being in clusters, so that the tree, at some distance, seemed not unlike a stem of the thick species of *coralline*. The leaves are the size of oak leaves, but not sinuated, and of a light though not bright green; the fruit is of the same colour, in shape almost conical like a pine, nine inches long, eleven inches and a half round the most swelling part, and with a soft velvet rind. Not being in blossom at that season, I had no opportunity to observe the flower. The fakir told me that there were only those four within 700 miles of the place; the seeds of them, which are shaped like a kidney bean, and as large as a *caravanfa*, having been sent for by one of the

\* And particularly of gypsum coloured by a red argil. To examine also why asphaltos is commonly found in the neighbourhood of salt-pits.

42. To observe the different efflorescence of the different salts formed on the rocks and the surface of the earth, in order to determine their nature.

43. To note also the nature, the abundance, and what may be discovered in regard to the origin of mineral waters: to determine the temperature of them. C.

† From the *Oriental Collections*, Vol. I.

emperors, and sown there. The groves and fashion of the ground, as well as the fruit-trees, and a large stone wall about them, indicate the place to have been once a garden, and it is called to this time *Bejum-ke Baug*, or the *Queen's Garden*.

On my arrival at Patna, on the 2d of January 1778, I luckily met with a gentleman named Kerr, celebrated for his skill in botanical researches, who told me that the above-mentioned tree was of the species classed in the Linnæan system under the name of *Adansonia*, a description of which is to be found in the sixth edition of his *Genera Plantarum*, printed at Stockholm 1764, p. 352.

V. *Account of a Banian Tree in the Province of Babar.*  
By Colonel IRONSIDE \*.

NEAR Manjee, a small town at the confluence of the *Devah* (or *Gogra*) and the *Ganges*, about twenty miles west of the city of Patna, there is a remarkably large tree, called a *bur* or *banian tree*, which has the quality of extending its branches, in a horizontal direction, to a considerable distance from its stem; and of then dropping leafless fibres, or scions, to the ground, which there catch hold of the earth, take root, embody, grow thick, and serve either to support the protracted branches, or, by a farther vegetation, to compose a second trunk. From these branches other arms again spring out, fall down, enter the ground, grow up again, and constitute a third stem, and so on. From the opposite pretty high bank of the *Ganges*, and at the distance of near eight miles, we perceived this tree of a pyramidical shape, with an easy spreading slope from its summit to the extremity of its lower branches, and mistook it at first for a small hill: we had no quadrant to measure its height; but the middle or principal stem is considerably higher, I think, than the highest elm, or other tree, I ever saw in England. The fol-

\* From the *Oriental Collections*, Vol. I.

lowing comprise some other of its dimensions, which were taken with a cord of a given length:—

	Yards.	Feet.
Diameter of the branches from north to south	121, or	363
Diameter of ditto from east to west	- 125, or	375
Circumference of the shadow of the extreme branches, taken at the meridian	- 372, or	1116
Circumference of the several bodies or stems, taken by carrying the cord round the outermost trunks	- - - 307, or	921

The several trunks may amount to fifty or sixty.

N. B. The dropping fibres shoot down from the knots or joints of the boughs.

This tree, as well as the *peepel*, and many other large trees in India, is a creeper. It is often seen to spring round other trees, particularly round every species of the palm. The date, or palmyra, growing through the centre of a banian tree, looks extremely grand; and yet none of the European landscape painters, who have delineated views of this country, have introduced this characteristic object into their pieces. I have frequently observed it also shooting from old walls, and running along them. In the inside of a large brick-wall it lined the whole circumference of the internal space of it, and thus actually became a tree turned inside out.

Under the tree sat a *fakir*, or devotee. He had been there twenty-five years; but he did not continue under the tree throughout the year, his vow obliging him to lie, during the four coldest months, up to his neck in the Ganges; and to sit, during the four hottest months, close to a large fire.

VI. *On the different Kinds of Cadmia, and particularly those of Zinc and Cobalt.* By I. I. BINDHEIM of Moscow.

[Concluded from Page 255.]

Of COBALT.

**I**T is scarcely a century and a half since people knew how to make use of cobalt ore. Brand, counsellor of the mines in Sweden, first proved that cobalt was a semi-metal, and that it possessed peculiar properties different from those of other metals. He defended his opinion against various objections that were made to it; but it is still believed by some, that it is a mixture of copper, iron, and arsenic: and this seems the more probable, as a fixed blue colour, fit for being employed in the arts and manufactures, is prepared with advantage at Vienna from iron and arsenic. This, however, does not place the circumstance beyond all doubt, for it still remains to be examined whether the arsenic and iron employed for that purpose be free from cobalt; and, until that be ascertained, the fact must be involved in uncertainty; for both, or at least one of them, may be mixed with cobalt.

Lehmann was of opinion, that the colouring matter of cobalt consisted of a fine alkaline earth combined with some particles of copper and iron; and he made experiments on this subject, by which he obtained blue glass. But from the description he gives of his experiments it does not appear sufficiently proved that ingredients free from cobalt were used for the mixture.

The reason why some may have been inclined not to ascribe the principle which colours smalt to a metallic substance may have been, that they employed for their experiments a cobalt ore free from arsenic, and did not apply a sufficiently strong heat, without which the regulus of cobalt is difficult to be fused, and not so easily separated: the principle which gives the blue colour to glass is, however, to be ascribed

ascribed certainly to the metal of cobalt, as has been placed beyond all doubt, and clearly proved by the experiments of M. Meyer, to be found in Sellers' Collections.

Some, on the other hand, have endeavoured to banish cobalt from the number of metals; but no one will certainly any longer doubt of its being a peculiar metal, since it is well established, that simple substances are properly considered to be specifically different when they exhibit various properties which other bodies do not possess, and that every substance is considered as simple when it cannot be separated into different principles, and be again formed from them. Now this is confirmed in regard to cobalt; and it is found that it not only possesses properties different from those of all other metals, but is itself a metal of a totally peculiar kind. Even though there be an analogy between iron, nickel, arsenic, and cobalt; and though, according to the supposed hypothesis, the regulus of cobalt is only a variety of iron, and that it is difficult, if not impossible, to separate it from cobalt; yet the latter still remains a metal of a peculiar kind.

The first and principal researches for discovering cobalt mines were made in the Saxon mountains, and these procured to that country an opportunity of carrying on a considerable trade with this production. Good cobalt ore, fit for colouring, is found at present, though not in such abundance, in Hesse, Wurtemberg, the Harz, Bohemia, Prussia, Silesia, and Sweden.

As far as I know, pure native cobalt has never yet been found; what is commonly pretended to be such, is mineralised by arsenic. It is found in an oxygenated state, and always combined with iron, and also mineralised with carbonic acid; in vitrious cobalt ore, by the sulphuric and the arsenical acids; and to this belongs the so called flowers of cobalt, found in tender reddish crystals: it is also found mineralised by arsenic, with a little iron, in dull grey cobalt ore; by sulphur and arsenic, with iron, in white arsenical  
cobalt

cobalt ore; and by a little sulphur, with abundance of iron without any arsenic, in sulphurated cobalt ore.

When such ore is treated in the fire, the arsenic evaporates, and the metallic and earthy particles remain behind, which, in order to be prepared for commerce, must be mixed with pounded quartz or sand, afterwards moistened, and then packed up in casks under the name of *sajlor* or *zaffera*. If very fusible glass be melted with a little cobalt ore, and if the mass be finely pulverised, it produces smalt, which, by washing, may be fitted for an article of commerce of different qualities and sorted. This smalt, however, contains in general an impure regulus of cobalt, which often consists of a mixture of cobalt, iron, arsenic, and nickel, and is called *cobalt speise*. If you wish to obtain a pure regulus of cobalt, you must choose for that purpose a cobalt ore as free as possible from foreign metallic substances. You must then roast it carefully according to the proportions of sulphur and arsenic which you find in it, and reduce it by adding carbonaceous matter to take up the oxygen, and a good alkaline flux at a strong fusing heat. If the cobalt ore employed contains bismuth, and is free from nickel, the regulus of bismuth will be found at the bottom of the reduced cobalt in a separated state. This regulus is not pure, and sufficiently free from iron; but it may be brought to purity, though with trouble and a considerable loss of the regulus of cobalt. To effect this, it must be calcined with borax, on a test, in the same manner as copper, until it is no longer attracted by the magnet. Some, however, are of opinion, that iron is not the only metal attracted by the loadstone, and that it exercises an attractive power over the finest blue colouring regulus of cobalt: but there are well-grounded objections against this idea, for that effect takes place only when the latter is not sufficiently freed from iron; and according to the experiments of Bergmann, a composition of one part of iron and three parts of cobalt is attracted by the magnet; but if the proportion

proportion of the iron be considerably less, that effect is not produced.

The specific gravity of a regulus of cobalt, purified as much as possible by the above method, is  $7.700^*$ ; its colour is a pale greyish blue, but it becomes somewhat darker when exposed to the atmosphere: it is finely granulated on the fracture, and requires a strong degree of heat to be fused, especially when no arsenic is present; and therefore it happens that it is so difficult to extract the regulus by fusion from cobalt ore which contains no arsenic. It is not, however, volatile, like the greater part of the semi-metals; and does not inflame and evaporate, but when calcined becomes a blackish oxyde.

When cobalt is pure, it dissolves in acids with a red colour; when it does not dissolve, it is a sign that it is prevented by some foreign mixture: if the solution be green, it commonly implies the presence of nickel.

With the vitriolic acid cobalt affords brownish red crystals; the nitrous acid dissolves it also of a red colour: by the muriatic acid regulus of cobalt is dissolved with difficulty, but its calx easily dissolves. This solution is red when cold, but when exposed to a heat of 80 degrees becomes green; it shoots into red crystals inclining to blue: if these crystals are dissolved in water, and a little of the muriatic acid be added, it produces that kind of sympathetic ink which becomes green when heated, and invisible when cold. The acetous acid dissolves the calx of cobalt also of a red colour. If such solutions are precipitated by volatile lixivious salts (ammonia), and the quantity necessary for saturation be added, it is redissolved of a dark red colour.

In the wet way the oxalic acid, and in the dry way iron, have the greatest affinity with cobalt. It combines with all metals except silver, lead, and bismuth. Regulus of cobalt unites only weakly with sulphur, but is fully dissolved by sulphat of pot-ash.

\* Bergmann Sciagr., but in his Dissertation on Nickel he makes it  $8.14$ .

VII. *Singular Cure of a young Woman, effected by expelling from the Stomach, &c. the Larvæ of certain Insects.* By M. ODHELIUS \*.

THE account of this singular case was transmitted to M. Odhelius, together with some of the larvæ, by M. Flank, surgeon of Carlstadt, who, during the course of forty years practice, never saw any of the like kind discharged from the human body. The patient, who was seventeen years of age, and who for three years had been quite regular, became indisposed in the year 1786, and complained of a violent pain and griping in her stomach, with a head-ache and confusion in the morning, a burning in the throat, and great lassitude. These symptoms were lessened after repeated eructation; but the disorder still increased. Mineral water with jalep powder was prescribed, and the larvæ began gradually to be discharged; but as the patient did not find much relief, and as she nauseated jalep powder, aloë pills, with jalep resin, and mercurius dulcis, were administered in its stead, and about a quart of mineral water each time; by which means these troublesome guests were gradually so completely expelled, that the patient, in the course of a few weeks, was perfectly cured. The larvæ were transmitted to the Cabinet of Curiosities belonging to the Academy of Sciences. Professor Wilke found, on examining them, that they were of the species described by Reaumur under the name of *Pers a queue de rat*†, and which belong to a kind of two-winged fly, called the Pendulous Fly, *Musca pendula* L.; because the larvæ are suspended, as it were, by a long thread, which is their organ of respiration. These larvæ, which the Professor examined, were of a yellowish-brown colour, from four to six lines in length, with a tail of about the same extent; a cylindric body, from half a line to a line in thickness, cut

\* From *New Transactions of the Academy of Sciences at Stockholm*, Vol. X.

† *Memoires pour l'Hist. des Insectes*, T. IV. Mem. 11. p. 443.



across somewhat obliquely before, and conical towards the tail. As the patient, before she fell ill, had used a great deal of milk and cheese, M. Wilke was of opinion, that some of the eggs of these flies had been conveyed into her stomach in the rind of the cheese.

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VIII. *On the Signs exhibited by Animals which indicate Changes of the Weather, with Remarks on other Prognostications.* By M. TOALDO \*.

THE fluids and solids of organised beings, and their animal machines, are constructed in such a manner that a certain degree of motion puts them in a good state, while an augmentation or diminution of it deranges and destroys that state. The fluids, which by their nature are easily moved, as well as the fibres, which are highly susceptible of irritation, are readily affected by changes of the surrounding atmosphere, and suffer from their impressions, whether the air varies in its weight or qualities, or is changed in regard to its elasticity. We find, among those who are sound and in perfect health, vivacity, good spirits, and great agility, when the air is pure and elastic; on the other hand, when the air becomes light and damp, and is deprived of its elasticity, it throws the body into a state of languor and debility. Valetudinarians, whose constitutions are delicate, or who are advanced in life, are much sooner sensible of the impressions occasioned by changes of the weather than those who are strong and robust. In general the senses of men, who in their way of life deviate from the simplicity of nature, are coarse, dull, and void of energy. Those also who are distracted by a thousand other objects, scarcely feel the impressions of the air; and if they speak of them to fill up a vacuum in their miserable and frivolous conversation, they do it without thinking of their causes or effects, and without

\* From his *Meteorological Essays*.

ever paying attention to them. But animals which retain their natural instinct, which have their organs better constituted and their senses in a more perfect state, and which besides are not changed by vicious and depraved habits, perceive sooner, and are more susceptible of the impressions produced in them by variations of the atmosphere, and sooner exhibit signs of them.

Until the new discovery of animal electricity little attention was paid to these signs, which were consequently ascribed to a certain natural prescience. But as the electric matter issuing from the earth diffuses itself through the atmosphere, it must penetrate and agitate the frail machines in question; and as it carries with it vapours and exhalations of various kinds, these must produce, on machines so delicate, different sensations, which make them move in a different manner; and, according as the received impression is agreeable or troublesome, they exhibit signs of joy or sadness; send forth cries, or are silent; move, or remain at rest; as is observed in all kinds of animals, without excepting man, when the weather is about to change.

In the last place, internal and animal electricity, which in all probability is the agent of life and the grand source of organic motion, must be as much subject to modifications as the external electricity, from which it acquires new force and activity by the vapours and humidity of the atmosphere, which absorbing the electric matter in abundance, or serving it as a conductor, draws it off from the animal machine. Hence arises that languor and debility which are experienced during wet weather and when the south winds prevail; and for the same reason the moisture which has penetrated the organs, at least those that are weak or have suffered any hurt or injury, or been exposed to some new agitation, produces uneasiness and occasions pain. It is difficult to explain clearly and with precision how all this takes place; that is, how the electricity is excited, and by what mechanism exhalations and vapours affect animals, and produce

these changes in their bodies, since we are not acquainted with the curious organisation of the most delicate parts of these machines; but we can observe and perceive the progress and general consequences of these phenomena, as well as of those by which they are produced. The following are the common and familiar signs exhibited by animals, which indicate changes of the weather, and which are not taken so much from the agricultural poet, who first collected them, as from common observation :

1. When the bats remain longer than usual abroad from their holes, fly about in greater numbers and to a greater distance than common, it announces that the following day will be warm and serene; but if they enter the houses, and send forth loud and repeated cries, it indicates bad weather.

2. If the owl is heard to scream during bad weather, it announces that it will become fine.

3. The croaking of crows in the morning indicates fine weather.

4. When the raven croaks three or four times, extending his wings and shaking the leaves, it is a sign of serene weather.

5. It is an indication of rain and stormy weather when ducks and geese fly backwards and forwards; when they plunge frequently into the water, or begin to send forth cries and to fly about.

6. If the bees do not remove to a great distance from their hives, it announces rain; if they return to their hives before the usual time, it may be concluded that it will soon fall.

7. If pigeons return slowly to the pigeon-house, it indicates that the succeeding days will be rainy.

8. It is a sign of rain or wind when the sparrows chirp a great deal, and make a noise to each other to assemble.

9. When fowls and chickens roll in the sand more than usual, it announces rain: the case is the same when the cock crow in the evening, or at uncommon hours.

10. Peacocks, which cry during the night, have a pre-sensation of rain.

11. It is believed to be a sign of bad weather when the swallows fly in such a manner as to brush the surface of the water, and to touch it frequently with their wings and breast.

12. The weather is about to become cloudy, and to change for the worse, when the flies sting, and become more troublesome than usual.

13. When the gnats collect themselves before the setting of the sun, and form a sort of vortex in the shape of a column, it announces fine weather.

14. When sea-fowl and other aquatic birds retire to the sea-shore or marshes, it indicates a change of weather and a sudden storm.

15. If the cranes fly exceedingly high, in silence, and ranged in order, it is a sign of approaching fine weather; but if they fly in disorder, or immediately return with cries, it announces wind.

16. When the dolphins sport and make frequent leaps, the sea being tranquil and calm, it denotes that the wind will blow from that quarter from which they proceed.

17. If the frogs croak more than usual; if the toads issue from their holes in the evening in great numbers; if the earth-worms come forth from the earth, and scorpions appear on the walls; if the ants remove their eggs from their small hills; if the moles throw up the earth more than usual; if the asses frequently shake and agitate their ears; if the hogs shake and spoil the stalks of corn; if the bats send forth cries, and fly into the houses; if the dogs roll on the ground, and scratch up the earth with their fore-feet; if the cows look towards the heavens, and turn up their nostrils as if catching some smell; if the oxen lick their fore-feet, and if oxen and dogs lie on their right side; all these are signs which announce rain.

18. The case is the same when animals crowd together.

19. When

19. When goats and sheep are more obstinate and more desirous to crop their pastures, and seem to quit them with reluctance; and when the birds return slowly to their nests, rain may soon be expected.

*Other Signs which announce Changes of the Weather.*

1. If the flame of a lamp crackles or flares, it indicates rainy weather.

2. The case is the same when the foot detaches itself from the chimney and falls down.

3. It is a sign of rain, also, when the foot collected around pots or kettles takes fire in the form of small points like grains of millet; because this phenomenon denotes that the air is cold and moist.

4. If the coals seem hotter than usual, or if the flame is more agitated, though the weather be calm at the time, it indicates wind.

5. When the flame burns steady, and proceeds straight upwards, it is a sign of fine weather.

6. If the sound of bells is heard at a great distance, it is a sign of wind, or of a change of weather.

7. The hollow sound of forests; the murmuring noise of the waves of the sea; their foaming, and green and black colour, announce a storm.

8. Good or bad smells, seeming as if it were condensed, are a sign of a change of weather; either because exhalations arise and are dispersed in more abundance, which is a sign of an increase of electricity; or because the air does not dispell or raise these exhalations, which indicates that the constitution of the atmosphere is motionless, light, and void of elasticity.

9. When the spiders webs and the leaves of the trees are agitated without any sensible wind, it is a sign of wind, and perhaps of rain; because it denotes that strong and penetrating exhalations arise from the earth.

10. These signs are less equivocal when the dry leaves and chaff are agitated in a vortex, and raised into the air.

11. A frequent change of wind, accompanied with an agitation of the clouds, denotes a sudden storm.

12. A want or too great a quantity of dew being a mark of a strong evaporation, announces rain: the case is the same with thick, white hoar-frost, which is only dew congealed.

13. If salt, marble, and glass become moist some days before rain; if articles of wood, doors, and chests of drawers swell; if the corns on the feet and the scars of old wounds become painful; all these signs indicate that aqueous vapours are exhaled from the earth, and are no doubt directed by the electric matter, which diffuses itself then in greater abundance and penetrates every body. Hence it happens that stones become moist, that wood swells, and salt becomes deliquescent by the moisture. When the stones after being moist become dry, it is a sign of fine weather.

14. On the other hand, when the weather inclines to rain, the water is seen to diminish in vases and fountains, because the humidity is then carried away by the evaporation of the electric matter.

15. It is certainly a surprising phenomenon to see the earth, after very long and very abundant rains, to be sometimes almost dry, the roads quite free from dirt, and the hands to become arid and parched. This is a sign that the rain has not altogether ceased, and denotes a continual efflux of electric matter, which being renewed carries with it, in the form of vapours, all the moisture that falls on the earth.

16. There is sometimes, however, a great deal of dirt even after a very moderate rain, which in that case is a sign of fine weather, because it indicates that evaporation has ceased. Dry stones and moist earth announce fine weather; dry earth and moist stones announce rain.

17. The winds which begin to blow in the day-time, are much stronger, and endure longer, than those which begin to blow only in the night.

18. Weather, whether good or bad, which takes place in the

the night-time, is not, in general, of long duration; and, for the most part, wind is more uncommon in the night than in the day-time. Fine weather in the night, with scattered clouds, does not last.

19. A Venetian proverb says, that a sudden storm from the north does not last three days.

20. The hoar-frost, which is first occasioned by the east wind, indicates that the cold will continue a long time, as was the case in 1770.

21. If it thunders in the month of December, moderate and fine weather may be expected.

22. If it thunders at intervals in the spring time, before the trees have acquired leaves, cold weather is still to be expected.

23. If the wind does not change, the weather will remain the same.

Such almost are the signs of the variations of the atmosphere; but I will not be answerable for the certainty of them all. Plutarch, in his Problems, where it is asked why a horse who has escaped from a wolf becomes fleet, replies, that because, by a single action, but executed with great force and vigour, he has acquired a disposition to running and a habit of speed; or perhaps, because he is naturally swift and agile: but he adds, perhaps neither of these is true. This observation, I am afraid, will apply to some of the vulgar prognostics of the present day. For example, we are told, that it is a sign of fertility in any year when a fly is engendered in an acorn of that year; and that it is the sign of a pestilential year, if there issues from it a spider. Should the reason be asked, it might be replied, that neither of these is true. I might venture to say as much of those popular tales in regard to certain critical days of the month; yet we must still have some respect for popular proverbs, which are often founded on observation and reason. Thus it is said, that if it rains on the 3d of May, the day of the Holy Cross; or on the 23d of April, St. George's day; or the

15th of June, St. Vitus's day, &c.; in the first case the nuts will be spoiled; in the second, the figs; and in the third, the grapes. All this may be true to a certain degree, that is to say, when it rains for a certain number of days about these periods; because, if rain falls at the time when fruit-trees are in blossom, it carries off the fecundating farina, and by these means renders them barren.

In regard to the general qualities of the seasons, and their influence, attention may be paid to the following signs:— If the earth and air abound with insects, worms, frogs, locusts, &c.; if the walnut-tree has more leaves than fruit; if there are large quantities of beans, fruit, and fish; if the spring and summer are too damp; if hoar-frost, fogs, and dew come on at times when they are not generally seen, the year will be barren: the opposite signs announce fertility and abundance. Animals seem also to foresee and prognosticate fertility or barrenness: it is said that when the birds flock together, quit the woods and islands, and retire to the fields, villages and towns, it is a sign that the year will be barren.

A great quantity of snow in winter promises a fertile year, but abundant rains give reason to apprehend that it will be barren. A winter, during which a great deal of snow and rain falls, announces a very warm summer. It is generally believed that thunder and storms in winter prognosticate abundance, because they fertilise the earth. When the spring is rainy, it produces an abundant crop of hay and of useless herbs, but at the same time a scarcity and dearth of grain. If it is warm, there will be plenty of fruit, but they will be almost all spoilt. If it is cold and dry, there will be few fruit or grapes, and silk-worms will not thrive. If it is only dry, there will be few fruit, but they will be good. In the last place, if it is cold, the fruit will be late in coming to maturity.

If the spring and summer are both damp, or even both dry, a scarcity and dearth of provisions is to be apprehended.



If the summer is dry, there will be little corn: diseases will also prevail; but they will be more numerous if it is warm. If it is moderately cold, the corn will be late; but there will be a great deal of it; and the season will occasion few diseases.

A fine autumn announces a winter during which winds will prevail: if it is damp and rainy, it spoils the grapes, injures the sown fields, and threatens a scarcity. If it be too cold, or too warm, it produces many maladies. A long severity of the seasons, either by winds, drought, dampness, heat or cold, becomes exceedingly destructive to plants and animals. In general, there is a compensation for rain or drought between one season and another. A damp spring or summer is commonly followed by a fine autumn. If the winter is rainy, the spring will be dry; and if the former is dry, the latter will be damp. When the autumn is fine, the spring will be rainy. That this alternation is in general verified may be seen in a Journal carried on for forty years, and formerly edited by M. de Poleni.

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IX. *On the Effects of Oil in Cases of the Bite of Serpents; republished from the Charlestown (South-Carolina) City Gazette\*.*

Messrs. FRÉNEAU and PAINE,

I READ with pleasure, in your paper of the 21st of November, "some short directions for the cure of the plague," composed from a small pamphlet lately published by Count Berchtold at Vienna, by the use of *sweet olive oil*.

To take off the sharp edge of misfortune, or to meliorate the condition of man, is a godlike employment. Count Berchtold will be deservedly classed by the philanthropist among the benefactors to mankind.

In great cities, particularly in London, a number of per-

\* From the *American Medical Repository*.

sons procure their livelihood by catching vipers. They are employed by chemists, apothecaries, &c.

I remember, some years before leaving England, to have read, in the Philosophical Transactions of the Royal Society in London, a curious circumstance relative to one of these viper-catchers.

A member of the society had received, casually, information that a man engaged in this business was frequently bitten, and that he cured himself by *sweet olive oil*. After considerable inquiry, the viper-catcher was found, and the questions asked, whether he did cure himself by the oil? and whether he was willing to gratify a number of gentlemen of the fact? The man answered affirmatively to both questions. Accordingly, a most numerous meeting of the Royal Society was convened, composed of a considerable number of the nobility, &c. The viper-catcher attended, accompanied by his wife, with a large viper; and laying his arm naked to the shoulder, suffered the irritated reptile to strike, which it did very forcibly. His wife permitted the poison to operate till her husband's head, face, and tongue were greatly swelled, his arm and face also very black, and his senses much affected, when he applied the oil, by pouring a small quantity down his throat, and bathing the part bitten. The man gradually and soon recovered.

This circumstance being strongly impressed upon my mind, and knowing that the poison of an English viper is considered in that country the most subtle in nature, determined me to try its antidotal power in the bite of the rattlesnake, the first opportunity which should offer, on my retirement from Charlestown to the back country, now called Pendleton County. I was also particularly impelled to make the trial, from a consideration of the newness and wildness of the country, and the number of my family, beside which there were hardly a dozen more in the country. This was in the year 1786.

In about a month after my arrival, a person in full speed

came to my camp, and most urgently begged to know if I could assist a man who had just been bitten by a very large rattle-snake. Although I lamented the misfortune, I rejoiced at the opportunity it offered to ascertain fully the property of olive oil as an antidote to this deadly poison; accordingly I put a phial of oil in my pocket, and mounted the messenger's horse.

When I arrived at the unfortunate man's cabin, he struck me as the most frightful object I had ever beheld. His head and face were prodigiously swelled, the latter black; his tongue proportionably enlarged, and out of his mouth; his eyes as if shooting from their sockets; his senses gone, and every appearance of immediate suffocation. He had been struck on the side of the foot, about the middle, in the hollow.

Immediately, but with great difficulty, I got down two table-spoons full of oil. Its effect was almost instantaneous, and astonishingly powerful in counteracting the poison, as appeared by the strong though quick convulsions that followed. In about thirty minutes it operated strongly, both emetically and cathartically; after which the swelling of the head, face, &c. gradually abated, and the tongue began to assume its place. In about two hours he was so far recovered as to be able to articulate, and from that time recovered fast. The oil, inwardly taken, and applied to the foot and leg, both exceedingly swelled, did not exceed seven or eight spoons full.

The number of cases, of a like nature, in the course of twelve years, has been considerable; in all which, olive oil has proved itself to be peculiarly adapted and fully adequate to the worst of cases, if timely applied. It is a remedy which every person may command (may have at hand when others cannot be procured), and ought not to be without; indeed, many cautious people here carry a small phial of oil constantly about them. It has also been used with equal success when horses, cattle, and dogs have been bitten. Thus

is the mind relieved from terror in those whose occupation subjects them to the bite of the snakes, from a well-grounded confidence in the certain efficacy of the oil, and to which every one may have instant recurrence.

The case, I am informed, has occurred, where the oil succeeded when given to a woman bitten by a mad dog, under strong symptoms of hydrophobia; but at present I am not sufficiently in possession of particulars to warrant its communication.

I can hardly excuse myself of criminal neglect in having so long omitted to make thus public this sovereign antidote to the worst of animal poisons. The knowledge of the efficacy of the olive oil is abundantly diffused in this county, and partially in some of the adjoining counties.

The insertion of the foregoing particulars in your City and Carolina Gazettes, must make its invaluable properties generally known.

With great esteem, I am, &c.

*Pendleton County, July 4, 1798.*

J. MILLER.

X. *Thoughts on Deafness; with a new Mode of making Deaf People hear. Written 15th December 1798, by D. WHYTE, M.D.*

*His Majesty's Ship Atlas,*

*Torbay, 9th August 1799.*

SIR,

HAVING seen in a late newspaper an account, copied from your Magazine, of a new mode of conveying sounds for the benefit of deaf persons, proposed by Professor Blumenbach, I have extracted from my Medical Diary what I wrote some months ago on this subject.

As my ideas were formed without any knowledge of the German discovery, you will oblige me much by giving them a place in your very valuable Miscellany.

I am, Sir, your humble servant,

*The Editor of the  
Philosophical Magazine,* }

D. WHYTE,

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IT has been a general remark, that deaf people speak in a very low tone of voice, while they themselves conceive that they speak very loud. It is supposed that the deaf person, not being so easily affected by sound, answers in what he believes to be the proper and corresponding pitch.

I came down last night from London to Gosport in the stage-coach : one of the passengers, a woman, was extremely deaf. A few weeks before, I had travelled in a similar vehicle with an unentertaining companion of the same kind. My attention has been thereby turned to the subject ; and I am led to make the following remarks :—

For that deafness arising from impaired excitability of the organ of hearing, properly so called, I know of no remedy : I confine what I have to say to that species of it which is occasioned by a diseased state of tympanum, or the external meatus.

In either of these last cases sounds communicated by the external ear appear to be of a lower pitch than in reality they are ; while, if the Eustachian tube continues permeable, those communicated through the mouth appear higher and louder than usual. Even where the ear and all its parts and passages are in health, sounds communicated through the mouth are more perfect than those which pass through the external meatus. This, perhaps, is occasioned partly by the concavity of the mouth, and partly by the solidity of the teeth. In persons whose tympanum, or whose external meatus is diseased, it is probable that the ear, from habit, becomes more sensible to the vibrations of sound communicated through the Eustachian tube, than, without such a circumstance, it otherwise would be.

Sound being more easily communicated through the medium of solid than of rare bodies, I apprehend that a long wire held in the mouth would be much more serviceable to such a deaf person, than the largest trumpet applied to the external ear.

It possesses also the advantage of being extremely portable,  
and

and may at all times be used without inconvenience, and almost without being observed.

I shall certainly make trial of it in the first case that occurs.

XI. *On the Assaying of Ores by Fusion.* By Mr. DAVID MUSHET of the Clyde Iron Works. Communicated by the Author.

MY Paper in the Number for July concluded with a table of the proportions requisite to obtain, from all the various iron-stones, an accurate assay; the perfection of which is always indicated by the superior transparency of the flux, and the super-carbonation of the metallic button. By scrupulously following these and similar proportions as the exigencies of the ore may point out, crude iron will always be obtained of the finest quality, carbonated beyond whatever is produced in the large way of manufacture, and its surface covered with a beautiful carburet of iron, either in small shining specula, or in the state of a thin membrane. By a slight gradation of change in the proportions of the component parts of the flux, the metal of the same iron-stone may be made to pass through all the inferior states.

Since, then, all iron-stones in the assay-furnace may be made to give out their iron at pleasure, of all the various qualities, it is surely erroneous to assert, that such and such iron-stones contain such and such qualities of iron; that this one affords metal of the finest quality, while that, on the contrary, yields iron fit only for forge-pigs or ballast; yet this is the universal language in the manufactory. In this, as in many instances, we accommodate the language to our ideas, rather than our ideas to truth. The suffrage of prevailing custom has imperceptibly associated with our ideas many absurdities which we are afterwards ashamed to acknowledge, and which darken the gleam of truth, or render

it apparently ridiculous, merely because it is at variance with our prejudices. Where science guides not the manufacturer, or is scorned by him, his train of reasoning, though far from being just, is short; it is fitted to the narrow culture of his mind, and consonant to a barbarous nomenclature of received usage\*.

In order to elucidate still farther how much the quality of the iron is dependent upon the proportions of the mixtures, in combination with, or given to the ores, let a determinate quantity, say an ounce, of the oxyde of pure malleable iron be taken;—this we are physically certain contains no mixture except oxygen existing in quantity proportioned to the stage of oxydation, the quantity being ascertained by its degree of obedience to the magnet; when the quantity of oxygen given

\* I cannot resist noticing one instance, prevalent at iron-works, of that blind reverence to the opinion of our predecessors, whose sources of knowledge must necessarily have been few and contracted. When super-carbonated crude iron is run from the furnace, it is frequently covered with a scurf, which when cold is found to be a coating of plumbago (carburet of iron) remarkably brilliant; sometimes in small specks, and at other times in large flakes: this substance is universally denominated *sulphur*, and, as the most expressive adjective for that quality, we say that the iron is *sulphury*. There are not, perhaps, two substances so opposite in their degrees of inflammability, or so widely different in their properties, as sulphur and plumbago; the existence of the latter almost wholly supposes a total absence of the former: yet, such is the want of investigation, or the slightest momentary reflection, that an indolent belief is passed as to the presence of a substance diametrically opposite to that which is expressed. *Sulphur* has hitherto been the philosopher's stone of the iron manufactory; to its presence is attributed the production of bad iron—when the metal is in its most valuable state, it is also *sulphury*;—it prevents cast iron from becoming malleable; and if *sulphur* were altogether absent, hard or white cast iron could not be produced. If cast iron is found coloured, it is by the *sulphur*; is it crystallised and coloured, then it has sulphur to excess; should it have lost its strength, or have become loose in the fracture by an excess of shrinkage in large castings, still it is by the agency of sulphur: in short, in every process in the manufacturing of iron, sulphur explains the whole phenomena! it is execrated in one process, and anxiously looked for in another.

to it, by the decomposition of water, exceeds 25 per cent. few traces of magnetic attraction are perceptible:—introduce this oxyde into a covered crucible, without any addition, and expose it to a violent degree of heat for 40 minutes, (longer in proportion to the quantity,) a button of highly oxygenated crude iron will be obtained: if the heat is continued longer than is necessary to effect this, a small mass of malleable iron will be found occupying the bottom of the crucible. The produce in either case will be short of the real quantity of metal contained in the oxyde. When oxygenated crude iron is obtained, the ore from which it is produced, to use the common phraseology, is said to contain *bad iron*. That this has no relation to truth, will be seen by taking another portion of the same oxyde; let it be mixed either with chalk or lime, and a little bottle-glass, to constitute fusibility, and exposed to a similar degree of heat with the former; the whole contents in iron will then be found revived, and occupying the bottom of the crucible in the state of fine carbonated crude iron. Here then is a complete alteration in the quality of the metal, though obtained from the same ore; for we cannot consider iron combined with oxygen, to which earthy bases are given, in any other light than that of an ore. Again, let a portion of mixture, exactly similar to the last, have added to it double or triple its weight of bottle glass, and subject the whole to an equal heat with the former experiments, nearly a complete revival of all the metal will be found to have taken place; its quality, however, will be highly oxygenated and brittle. Such experiments clearly demonstrate, that the various qualities of crude iron are entirely owing to the mixtures in the ore, and their treatment; and that iron, considered as a simple metallic substance, is the same in point of quality in all ores.

If iron was originally formed in a metallic state, its property of decomposing water, whether casually exposed to a moist atmosphere, or removed at various depths from the surface, furnishes an hypothesis as to the primitive principle



of iron ores; that part of the water—by far the greatest—which remained undecomposed, would serve as a medium, or vehicle of suspension, and conveyance to the oxyde; this again, in its turn, would be deposited either at the fountain-head, or at a greater or lesser distance from it, according to the affinities exerted upon it by other substances with which it might come in contact. Corresponding with this supposition, we commonly find those ores which are formed in vertical masses or knobs, approached by a great number of small veins occupying the smallest fissure or crevice in the rock. Time, and the re-action of additional water and acids, would a second time carry off a portion of the ore in chemical union; this, by the exertion of new affinities, would become precipitated, and mixed with the suspended earths, to form regular strata of iron-stone. To such a primary and secondary agency of formation may be attributed the general superior richness of ores found in irregular vertical masses, to that of iron-stones. The same cause will also explain why more determinate qualities of iron are obtained from primitive ores, than from those of a secondary formation. In the former, the mixtures are commonly fewer, and the quality of the malleable iron more decided; in the latter, the quality of the metal is less certain, and more various, from the mixtures being more numerous. Hence we may also trace the reason of the superior qualities and marks possessed by some of the foreign fabrics over each other, where the same fuel has been used, and the same course of manufacture followed.

Having so far considered crude iron, in regard to its fusibility, and the facility with which it becomes changed into various degrees of carbonation or oxygenation, constituting a variety of qualities most pointedly distinguished in commerce, and in which the metallurgist discovers widely different properties and characteristic forms; I shall next proceed to mention in what manner strength may be given to any quality of crude iron which may probably be obtained

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by the fusion of an ore, and from what source this property is derived.

Upon a former occasion I have mentioned that iron, obtained from argillaceous ores, possessed a degree of strength beyond that obtained from the other genera. This truth daily presents itself to our observation in the large scale of manufacture; and however erroneous the reasoning of the manufacturer as to the cause, yet so evident are the consequences produced, that we must immediately attribute them to some source beyond the casualties of operation in the smelting furnace. In the explanation of this fact, as on the degrees of oxygenation and carbonation in general, the manufacturer has recourse to the existent nature of the iron in the ore, and denominates the metal contained in such and such an ore to be “strong, coarse, ill-melting iron;” or “weak, tender iron, possessing no body.” That iron-stones and ores yield, in the operation of smelting, different qualities of crude iron, as to strength, is an undeniable fact; and that the same variety attaches to iron when converted to malleability is a truth daily evinced in our forges: yet these facts by no means entitle us to conclude, without farther investigation, that these varieties of strength are the hereditary property of the pristine formation of the metal. This inference accords with a hasty view of the matter, and a bare comprehension of effects, without tracing to its source the modifying principle of the whole. The theory which I have adopted, and which in every step I have found supported by numerous experiments, upon different scales, and by a long course of practical observation, explains to me, with much more ease and harmony, the whole phenomena of quality in ores and iron-stones.

To illustrate that part of my theory relative to strength, let the preceding experiment, wherein carbonated crude iron was produced from the oxyde of pure iron, be repeated with the addition of a little pure clay. If the clay added be half the weight of the lime also used, the iron will be found,  
when

when subjected to the gauge, much superior in strength; and if the experiment be accurately performed, the metal will be but a little reduced in point of carbonation. The following proportions will give accuracy to the result:—Oxyde of iron, 4 parts—Lime, 2—Clay, 1—Glafs, 3 = 10 parts. By mixing clay with the flux in all experiments, the strength of the crude iron is improved. This point may be urged so far as to form, by an extra-addition of clay, a flux of difficult fusion; in which the iron becomes suspended in globules, which are partially malleabilised apart from each other. Crude iron, obtained with a superior mixture of clay, in all its stages of quality, possesses a greater degree of strength than iron from calcareous iron-stones. Iron from argillaceous iron-stone is reckoned strongest when carbo-oxygenated; that extracted from calcareous iron-stone is reckoned to possess most strength when oxygenated, mottled. I would far exceed the limits of the present communication, were I to enter fully into this curious subject, and particularise the different results obtained by the fusion of ores with different earths in various proportions: all my experiments have fully proved to me, that originally the quality of the iron, simply considered, was the same; that, as it underwent change by decomposition and new combination, it became united to foreign substances, possessing widely different properties; and which mixture, by a general fusion, imparts to the metal various properties, seldom homogeneous, but frequently otherwise: in short, that the numberless mixtures with which it is combined are not neutral in fusion, but convey an alteration to the quality of the reduced iron. I hope to resume this subject when my experiments will be more extended by the examination of a vast variety of iron-stones, and shall then point out the consequent effects of their application to the manufacture of cast and malleable iron.

The assaying of primary ores comes next under consideration. These, I have already said, possess a much greater diversity of external character, as well as internal variety, than

those of iron-stone. When assayed with a vitreous flux, either of salts, alkalies, or flux, the results are rendered very uncertain and erroneous: when pot-ash, tartar, &c. are used, the crucible is often destroyed, and the compound entirely lost: when bottle glass and a mixture of these are used, the scoria formed is so very black and ponderous as to give the most presumable indication of the secretion of metallic oxyde: this is afterwards verified by fusing the mass with a mixture of dried chalk and charcoal, a globule of metal will be obtained, which evinces the richness of the scoria; this, having lost its colouring principle (the metal), becomes clear and transparent. The results from these ores by fusion afford various products, and lead to different conclusions: I shall mention several of them.

The Cumberland iron ore, when introduced into a crucible without any additional mixture, fuses easily, and forms an opaque scoria, internally of a black colour, but towards the surface covered with fine shades of brown: this arises from a partial oxygenation of the semi-revived metal while cooling, and is often injured by a fresh combination of oxygen. If the crucible remains sound, and the melted mass is kept in a state of extreme division for an hour, a considerable quantity of metal will be found precipitated, but so highly oxygenated as to shiver to pieces if exposed to air before it is entirely cooled. If, when the crucible is taken from the furnace, it be slightly inclined to one side, and the vitrified fluid entirely removed from the surface of the metal, a violent deflagration will immediately ensue, the ejected globules will be thrown three feet upwards from the mouth of the crucible: if the quantity of metal does not exceed 500 grains, it will totally disappear, except a rough dark-blue oxyde in the bottom of the crucible, not above 1-4th of the original weight. The metal thus oxydated will be found in small spherules of a blackish colour, and spongy around the spot occupied by the crucible.

This curious appearance is in fact a combustion of iron  
by

by oxygen gas, furnished by the decomposition of atmospheric air: it is an operation which the accurate observer may daily see manifested in almost every department of the foundery and forge. By a just comprehension of it, and a proper appreciation of its effects, we have a key for the elucidation of the source and action of many facts long wrapped in mystery, or which have been explained upon principles destitute of stability, and unallied to the fundamental operations of truth.

In place of withdrawing the crucible immediately upon the separation of the crude iron, were it to remain for an hour longer under an inferior degree of heat, so as to consolidate the metal without again fusing it, then the whole mass would be found malleable; the scoria light and porous. In one of my experiments upon the hæmatites variety, I obtained from 1 lb. averdupoise, or 7000 Troy grains, an ingot of fine malleable iron weighing 4486 grains; a produce equal to 64 *per cent.* \*

An oxygenating flux was however used, and nearly the whole contents in iron previously revived. In experiments without the addition of a flux, the transmutation from cast to malleable iron is shortened, but the produce is not more than 5-8ths of the intrinsic contents of the ore. Even this process may be considerably shortened by removing the covering of vitrified earths floating upon the surface of the metal: thus the small portion of the carbonaceous principle constituting fusibility is almost instantly carried off by the combination of oxygen; the metal loses its fluidity, becomes thick and clotted, and more speedily passes into the malle-

\* This might be adduced as a proof that crude iron contains more parts congenial to malleability than is generally admitted, or than is manifested in the operation of converting it into malleable iron at the forge: the loss there has already been mentioned to amount to from 30 to 50 *per cent.* of real metal; in this assay, however, the produce in malleable iron was only 4,5 less than when accurately assayed, and rich carbonated crude iron was obtained; in which, too, the carbon constituted a part of the weight.

able state. In this process the quantity of malleable iron obtained is still less than in the two former: the surface of the metal being exposed by the removal of the scoria, oxydation takes immediate effect; and whilst malleability is pervading the under surface of the metallic button, the upper one becomes reduced to a blackish blue oxyde. In this operation a striking proof is afforded of the great affinity which oxygen has, in high temperatures, to caloric. Were the surface of such highly oxygenated crude iron exposed, while fluid, to atmospheric air, at an ordinary medium, for 1-6th of the time, its whole metallic properties would be completely destroyed: in the present instance nearly one-half of the metal is preserved, although its surface is exposed to the action of a violent current of gas, ignited to the highest pitch of whiteness\*. In the proper assay of this ore I have found all the varieties

\* I have frequently observed, in experiments with pretty deep crucibles, where the most violent heats were excited, and where the fluid metal had assumed a whitish-blue colour somewhat inclining to azure, that the quantity of oxyde formed was imperceptible, and never visible while the heat was continued of equal intensity; when this agent became less urgent, the surface of the metal became oxydated as usual. When a regulus of crude iron thus exposed was wished to be obtained free from oxydation, a little dry charcoal was introduced into the crucible so as to cover the regulus; this prevented the action of the air from taking effect while cooling, and preserved the button smooth. During such exposures, when no oxyde was produced, I have noted a loss of metallic parts equal to 5.7, or 10 per cent. when the space of time did not exceed one hour. Among several conjectures respecting the cause of this deficiency in weight, and real abstraction of metal, the two following have with me most weight. 1st, Either the metal disintegrates in small particles, which are thrown out of the crucible in sparks, made invisible by the transcendent brightness of the surrounding heat: Or, 2d, that in consequence of the fluid metal being exposed to such a great degree of heat, in contact with oxygenous gas, part of it becomes acidified, and forms the ferric acid. The truth of this last supposition will not easily be ascertained, since it will be difficult to construct an apparatus capable of receiving or containing it, should it prove to be an elastic fluid: it is, however, consonant to the doctrines of the new theory, and the possibility of the existence of the ferric acid is by no means excluded. The dissipation of carbon

varieties susceptible of various degrees of carbonation : for the most part I have used chalk and charcoal for the reduction of the ore into carbonated crude iron. In the hæmatites variety, for 1 lb. averdupoise I have commonly added 6 oz. dried chalk and 3-4ths oz. of charcoal ; and for the splinty blue ore also a similar mixture. From both of these I have obtained the richest sort of crude iron. In the manufactory these varieties are always reckoned to produce the hardest and most infusible qualities of crude iron : when the

carbon or oxygen will not nearly explain this phenomenon, as they exist in much less proportion ; and while the iron remains in a crude state, the latter accumulates in proportion as the former becomes expelled. Besides, a greater product in malleable iron is obtained by following the precautions formerly mentioned, than even of cast-iron when thus exposed. Now, as malleable iron is free from all mixture, or at least is malleable in proportion as it is unalloyed, it is obvious that the deficient weight is not made up of either oxygen or carbon. In the exposure of one particular button of crude iron, which lost  $9\frac{1}{2}$  per cent. the surface was agitated in an uncommon and most beautiful manner ; a rapid motion from the extremity of the circumference to the centre of the fluid mass took place ; the motion seemed entirely rotatory, and peculiar to one common axis. The metal itself was of a blueish green colour, and emitted from its surface an azure-coloured gas, which preserved a distinct form and colour from the common flame. This appearance first led me to suppose the presence of the ferric acid, by which means the loss of weight, when no oxyde was visible, would be easily accounted for. To try, so far, the justice of this conjecture, I exposed tin, lead, and zinc, in different alloys of these metals, to white heats, and found them dissipate in a much shorter time, and with a greater discharge of gas from their respective surfaces. The same effect was more speedily produced by introducing the pieces upon the surface of hot melted crude-iron. Zinc, in this experiment, inflames instantaneously ; explodes with considerable violence, and with the disengagement of a blueish flame. Its known inflammable property may add little strength to this hypothesis ; but the dissipation of lead and tin, without any residue, would also lead to a supposition of the plombic and stannic acids being formed by a complete saturation of oxygen. The latter, being found formed by nature in a crystalline form, does not entirely contradict this idea ; for a difference in the dose of oxygen, and of temperature, must alter the result.

metal is subsequently manufactured into bars, it is stated at different places to produce cold and hot short iron.

The kidney ore will admit of a diminution of chalk, and a small addition of glass; 1 lb. averdupoise of this variety will be accurately assayed with the addition of 5 oz. chalk, 1 oz. of glass, and 3-4ths oz. of charcoal. The same proportion of mixtures will also accurately reduce the small pieces of this ore, commonly of a soft, greasy consistency, mixed with small fragments of the hæmatites and kidney, and will give out the iron which they contain super-carbonated. A mixture of this soft ore with kidney is preferred to the richer varieties at the iron manufactories. The Lancashire ore chiefly consists of this compound, and the poorer in iron has always a decided preference given it at the blast furnace.

The stratified iron ore of the island of Islay is of most difficult fusion when treated without any addition. It fuses into a blackish green ponderous mass, and, even exposed to the highest heats, lets fall but a small share of its iron. The quality thus obtained is in the highest degree oxygenated; its fracture is partially crystallised in lines which converge towards the upper surface of the button, similar in crystallisation to the fracture of zinc. A regulus thus obtained, when divested of its scoria, and properly exposed to the action of the ignited gas, soon loses its fluidity, and passes into the state of strong malleable iron. If this operation is performed upon a large quantity, without agitating or turning the mass, the upper surface of malleable iron will early acquire the cold short quality, and will be subject, at the same time, to an uncommon waste by the rapid oxydation of its parts. In assaying this ore for the production of carbonated crude iron, the results are obtained with considerable difficulty; seldom perfect till the second or third experiment. This is chiefly owing to the great variety of quality in the stratum, two pieces seldom being alike either in appearance or in reality. The inferior masses yield from 44 to 48 per cent;



cent; and the superior qualities I have found as rich as 56 to 61 *per cent*. To obtain carbonated crude iron from the richest varieties of this ore, add to 1 averdupoise lb. of it 7 ounces of dried chalk, 3 of bottle-glass, and 1 of charcoal. This mixture will produce soft crude iron, possessing great strength, and an uncommonly large crystallised grain. The poorer qualities require an additional quantity of calcareous earth, to restore the equilibrium lost by the substitution of silic in place of iron. This ore had a trial in the large way at Clyde Iron Works, but was found to yield *bad* iron with the *usual* proportion of fuel.

Opposite in its quality and results is the beautiful ore of the island of Elba. This, when presented to a requisite proportion of carbonaceous matter, to take up its oxygen, not only clears itself of this hurtful mixture, but also takes up a considerable portion of carbon, which, in fusion, becomes united to the metal, and constitutes it perfectly carbonated. In experiments with this ore, I found that when 2 ounces of it were treated with  $2\frac{1}{2}$  oz. chalk,  $\frac{1}{2}$  oz. bottle-glass, and  $\frac{1}{4}$  oz. charcoal, the mixture was with difficulty reduced to a white glass; which at no time had been sufficiently divided to allow a general gravitation to the many globules of beautiful carbonated iron thus separated. In fusion, therefore, *per se*, the metal precipitated becomes greyish, and, in many instances, affords similar results to a pure calcareous iron-stone; with this principal difference, that it abounds with nearly a double quantity of metal, whose tendency to become carbonated is no-ways inferior to any iron-stone of that class. A smooth carbonated regulus will be obtained from this ore, by using the following proportions: Ore in a raw state, 2 ounces; chalk, 2 ounces; bottle-glass,  $1\frac{1}{2}$  ounce; and charcoal,  $\frac{1}{4}$  ounce. The scoria resulting from this fusion will be of a light-blue colour, clouded, and variegated like an agate, and very transparent. The great distance of Elba from this country precludes the possibility of using this ore in our manufactories with any

profit, unless it could be brought home as ballast, and delivered in the vicinity of any iron-work at 22s. per ton. The products obtained from it in the assay furnace, indicate, in an uncommon degree, how very valuable the quality of crude iron would be in the scale of manufacture, by its application.

The Norwegian, Danish, and Swedish ores, found in strata, resemble, in many points, the Scotch ore of the island of Islay; in assaying them a similar treatment is necessary. Some of them are more fusible, and afford singular qualities of crude iron. When fused with oxygenating fluxes, the metal produced is uncommonly hard and brittle; exhibiting a fracture studded with brilliant mirrors, diverging the light in small radii: even when fluxes are used, capable of conveying carbonation, the metal exhibits this bright granulated fracture in a great degree. One of the ores from the mine of Houban, upon being exposed a considerable time after separation, afforded a mass of pretty good steel. The proportions necessary to assay these, with accuracy, so intimately depend upon their richness, and the relative proportions of mixture with which the iron is combined, that the same recipe can seldom be applied to more than one variety. As iron-stones are more defined, and their treatment prescribed by more certain rule, a knowledge of them will soon lead to a just comprehension of the primary ores; a second experiment, therefore, with any of them, will be sufficient to point out the necessary proportions for obtaining in the next assay carbonated crude iron. In one collection of Norwegian ores I found the following variety:—

No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	
18	- 21	- 35	- 47	- 55	- 63	iron
17	- 16	- 19	- 11	- 24	- 19	parts volatile
65	- 63	- 46	- 42	- 21	- 18	earths
<hr/>						
100	100	100	100	100	100	

This

This simple table will shew plainly how necessary it is to accommodate the flux to the variety of the ore. If from this collection you wish to obtain carbonated regulus, it is obvious that, in order to saturate them equally, the iron contained in No. 3 ought to be presented with double the quantity of carbon necessary to carbonate No. 1; No. 5 with a triple quantity; that of No. 6 with more than  $3\frac{1}{2}$ : and as I have proved that this effect will be chiefly produced with the use of a calcareous earth, it will at once be conceived how far this substance is to be used as the instrument of alteration.

In the recipes adduced in this and the preceding paper, I have always noted charcoal as a constituent of each mixture. Since I discovered that the contact of calcareous earths conveyed carbonation to the metal, by the decomposition of the carbonic acid, I have reduced the proportion of charcoal commonly used in the flux, and have, in the treatment of most iron-stones, even abandoned it altogether: however, as my experiments have not yet extended universally to primary ores, I have, in the mean time, retained it as a constituent part of the solvent.

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XII. *On the Comparative Height of the Mountains of the Earth, the Moon, and Venus* \*.

SCHROETER, the learned astronomer of Lilienthal, who has several excellent telescopes by Herschel, published some time ago a work on the height of the lunar mountains, as compared with those of the earth; and lately he has published a new work on the height of the mountains of Venus. Faujas, who not long ago undertook a journey into Germany, of the utmost importance to the sciences, brought back with him these two works of Schroeter. We there see the manner in which that indefatigable astronomer makes

\* From the *Journal de Physique, Prairial, An. 7.*

his observations. It is by the projection of the shadows formed by these mountains when they begin to appear on their horizon in regard to us, or when they are about to disappear below the horizon. He distinguishes the mountains into different orders.

The plate in Schroeter's work consisted only of outline, and he expressed the diameter of the three globes merely by straight lines. The annexed delineation (See Plate VIII.) was drawn by Alexander Faujas, the son, who to military talents unites a strong attachment to the sciences. He has rendered the height of the mountains more just, and, from his drawing, the respective magnitude of the three globes can be better estimated. It is here seen that the moon, which is about forty-nine times smaller than the earth, has mountains more than 4000 toises in height \*; while that of Chimborazo, one of the Andes in South America, the highest mountain of our globe, is little more than 3000. Venus, which is less than the earth by a ninth, has mountains 23,000 toises in height. It must here be remarked, that the highest mountains on these three globes appear all to be volcanic.

**XIII.** *Description and Use of a new Portable Instrument for ascertaining the Comparative Strength of Gun-Powder.*  
By C. REGNIER †.

**I**N the processes employed for the improvement of gun-powder, it is necessary to make comparative experiments; and various ingenious inventions, which it is unnecessary to describe, as they are well known, have been used for that

\* The French toise is to the English fathom as 1 to 1.0664.

† From *Mémoires explicatives du Dynameter et autres Machines inventées par C. Regnier*, 4to, Paris, An. VII. The instruments here described are, 1. The dynamometer, of which a plate and description were given in the Philosophical Magazine for September 1798; 2. A safeguard for the priming in muskets; 3. The powder-proof above-mentioned; and, 4. An electrical machine.

purpose. I shall, therefore, only observe, that trials of gunpowder on a large scale are always the best; but as such experiments require certain kinds of apparatus and conveniences which are not always at command, a small powder-proof, in the form of a pistol, the blast of which drives a small toothed or turned wheel that rubs against a spring, and is moved through a greater or smaller space according to the strength of the powder, has been long ago adopted and brought into common use. This machine, however, is very defective in regard to the results which it gives, and can be of no utility when an absolute or approximate indication is required of the relative strength of a given weight of powder intended for fire-arms, which are loaded with quantities determined in this manner: these proof-instruments have indeed an arbitrary graduation, and their friction varies according to the strength of the spring and the cleanness of the mechanism.

To obviate these inconveniences, I made several experiments, which led me to a more valuable and accurate principle; and, with some variations, I at length fitted a small brass cannon to the spring of a common weighing instrument. By this application I was enabled to weigh the effort of the blast, and consequently obtained a comparative method of ascertaining its action. This instrument is attended likewise with this valuable advantage, that it acts without friction. Its graduation is accurately determined, because it expresses the weight which served for that purpose; and it may likewise be applied for weighing such bodies as come within the limits of its scale.

A perspective view of this instrument is represented, (Plate IX. fig. 1.) BC is a spring bent so as to form an angle; D a small brass cannon capable of containing exactly 15' grains of fine gunpowder; E the graduated arc, each division of which is nearly equal to 2' pounds avoirdupoise, and terminating in a screw that serves as a breech pin to the cannon. F is a cap which may be considered as

the

the body to be projected. It closes the mouth of the small cannon, upon which it presses with a force equal to four kilogrammes. This cap is strongly fastened to one of the spring radii by a nut at the opposite end of its tail. G is a piece of strong brass wire, fixed to a projection, which, by means of a small screw, is riveted into one of the radii. H, an index of woollen cloth or leather, which slides with a gentle friction on the wire, when the branches of the spring are pressed together by the explosion of the powder. This index remains at the place to which it has been pushed, and shews exactly how far the springs have been made to approach. When the instrument is to be used, the two extremities of the spring are to be pressed together, to separate the cap from the mouth of the cannon, into which powder is poured, till it is exactly full, by means of a card or a piece of paper. The stopper is then suffered to approach the muzzle gently, so as to close it exactly, without leaving a single grain of powder between them. The circular piece of cloth or leather, which supplies the place of an index, is to be brought into contact with that branch of the spring to which the tail of the stopper is fixed; and priming being put into the small pan of the cannon, it is discharged, the instrument being held suspended by a string or ribbon. The effects of the explosion are, that, as the powder occupies a greater space by its inflammation, it drives back the stopper, and the latter carries with it that branch of the spring in which its tail is fastened. This branch cannot move, in regard to the other, which is made to move also by the recoil of the gun, without driving before it the small index piece; and the space over which the index piece is carried will shew the force of the powder.

The arches moved over by the explosion of the different kinds of powder will shew, by the number of degrees, the comparative strength of each. A star is marked on that arch which shews the strength of powder of a mean quality; so that the relative value of any sample, in regard to that medium,

medium, may be known. The friction of the index is the only friction to which the instrument is subject; but it is so small that it may be considered as of no consequence. When the index is worn out, its place may be easily supplied by a new one. It may be readily comprehended that, by adding a hook to the perforation at the extremity of the divided arc, and a ring in the eye of the stopper, the instrument may be employed for weighing.

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XIV. *Account of a Red Substance observed on the Surface of a Fish-Pond in Norway.* By Professor H. STRÖM \*.

**I**N the spring of the year 1790, a pellicle, or substance of a red colour, was observed on the water at one end of a fish-pond in Norway, which soon after began to spread till it covered the whole surface. During dry and warm weather, the red colour was more perceptible than when it was cold and wet. It was more visible also at noon, than in the morning and evening. I, however, did not pay much attention to it until the colour, about the end of June and the beginning of July, became stronger than it had ever been before; it was strongest at noon, and always proceeded, in regular order, from the end of the pond till it gradually extended over the whole surface. I filled a beer glass with the water, which had a red appearance in the glass; but the red matter soon deposited itself at the bottom, and the water became yellowish: for a long time, however, it had a frothy pellicle, which was sometimes of a red and sometimes of a green colour. I let fall a drop of this pellicle on my microscope, and beheld the singular phenomenon exhibited in the annexed engraving, (Plate IX. fig. 2.) which represents this drop as seen when magnified.

\* From *Transactions of the Society of Natural History at Copenhagen*, Vol. I. Part 2.

I beheld partly large and partly small bubbles, resembling bright specula, surrounded by a dark rim or margin, which were sometimes like small rings (1,1), and sometimes broader; so that the bright speculum in the middle formed the smaller part (2,2). Every where around were seen an immense number of minute globules of the size as represented in the figure; consequently astonishingly small in regard to the specula, but similar to them in this respect, that they had a bright point like a speculum in the middle. At first, as far as I could observe, they were black, or of a dark colour, the bright point excepted; but the red colour afterwards shewed itself very clearly. In those that were red, the bright point was always seen; but this was not always the case with the dark ones. All these round bodies or globules appeared at first, though very seldom, to have some life and motion, but afterwards they entirely lost all movement; and this was the case in particular with the red, which seemed entirely lifeless. I could also clearly observe, that the red matter, which deposited itself in abundance at the bottom of the vessel, was nothing else than an assemblage of such round globules which had lost all life and movement. Besides these round globules with a bright point in the middle, I saw in the pellicle on the water, as well as in the water itself, another kind of living animals in greater numbers (3); which were shaped like small fish, and perfectly similar to the *Cercariæ virides* of Müller \*, which produce the green covering on stagnant water; but with this difference, that they were no larger than they are represented in the figure, and that they had not a green but a dark appearance. I observed also, though with difficulty, that the tail was forked; and that some of them, close to the tail, had a bright point or reflection, while the body before was not brighter than that of the *Cercaria viridis*. These small animals moved with great alertness and vivacity in the

\* See his *Animalcula infusoria*, No. 130, p. 126.



drops of water; but they collected themselves sometimes together (5 and 6), and tumbled several times round in a circle (4). I observed also, that, when they began to lose life and animation, their longish figure was changed, and they assumed that of a triangle or funnel, with a tail or tube (5). Müller observed the same thing in the *Cercaria viridis* \*, and at last they acquired the form of a globule, which is represented also in Müller †. I have no doubt that these globules were the same round animals, though dead, of which I have already spoken; especially as Müller says of his *Cercariæ virides*, that they can assume a globular form. Of the bright points in the middle he says nothing; and it appears singular to me that he did not observe them, as he viewed them much more magnified than I did. He says as little of the red colour which they can assume and communicate to the surface of the water, and nothing at all of the bright bodies or small specula inclosed in round rims, which were perfectly like the small round globules with a bright point in the middle, only that they were some hundred times larger. But I dare not affirm that they were of the same kind, and only different in size. It is very probable that they consisted of the slime of the dead *Cercariæ*, which formed bubbles by means of the air inclosed in them; for, that they were round like bubbles, appears from this circumstance, that they eluded every impression, and sometimes divided themselves into two or more smaller bubbles, and even by a stronger impression extended to a longish, oval, and irregular form like those marked (6), which shews that they consisted of a tough slimy substance. Among some small animals of another kind, seen sometimes in the drops of water, none were more conspicuous than the *Brachionus urccolaris* ‡, by its transparency, and the three or four round balls, or *ovaria*, which it has at the hind part of

\* *Animalcula infusoria*, Tab. 19. fig. 9.

† Fig. 7 and 13.

‡ Müller's *Animalcula infusoria*, No. 377, Tab. 50. fig. 15. 21.

its body. But what distinguished it most was, that, with the bristles or hair at the fore part, it often put the water in a sort of vortical motion, which made the small lifeless globular animals move quickly round in a circle, as if they had been alive (7). Such was the nature of this substance for a few days in July, till it increased more and more; and I found, when I filled a glass with it, a covering on the surface, of the thickness of the finger, besides the matter deposited at the bottom; but no living beings were now observed in it, and not many of the dead globular animals: they seemed all to be converted into the above red slimy matter, the colour of which was perfectly similar to that of the bright yellow ochre used for painting houses.

What I have above said will sufficiently shew that the red colour of water, which has so often been a matter of terror to the superstitious, may arise from the innocent infusion of animals; and that animalculæ, like those which I saw in fresh or stagnant water, may be found in salt water or the sea, will be doubted by no one who knows that the latter has its infusion animals also. We often read in books of voyages, that the sea has sometimes had the appearance of blood, sometimes of snow or milk; and that it has even sometimes had an appearance as if on fire. All these phenomena can be ascribed to nothing else than the foreign matters, and particularly small animals, which multiply there in immense quantities, and are sometimes red, sometimes white, and sometimes of a flame colour, like Müller's *Trichoda ignita*\*, without including the *Nereis noctiluca*, and several others. It seems to me highly probable that, in regard to colour, they may be subject to different variations; as is the case here, from black to red, and even from red to green; as appears from this circumstance, that the red skin or pellicle, after standing a few days in the glass, was in some parts green. It is also probable that such small animals may arise from

\* *Anim. infusoria*, No. 203, p. 186.

the so called *Grönfske*, which in spring is seen in the Norwegian seas; especially as it rises or falls according to the heat or cold. The uncommon colour in water, which I have here described, is a remarkable phenomenon; and, during the eleven years I resided in the neighbourhood, I never saw or heard of any change of the like kind in other fish-ponds. I therefore paid more attention to it, and especially as in former times such appearances were considered as portending wars and bloodshed: but these superstitious notions must lose all credit when the above explanation is adopted, and when the secrets of nature are more accurately explored. In regard to the cause of this phenomenon I must confess that to me it is inexplicable; and that it is easier to say what it is not, than what it is. It is well known that the quality of the atmosphere, some years, can produce worms and insects in incredible numbers: but what kind of weather is necessary for the generation of these infusion animals, and whether a continual alternation of rain and sun-shine, which was the case in the summer above mentioned, contributes to the phenomenon, is difficult to be determined.

P. S. The red matter continued on the water during the whole month of August, and seemed still thicker; but the red particles were smaller, and seemed entirely destitute of life. The corrupted and green water below swarmed, on the other hand, with the *cercariæ* already mentioned; which sometimes appeared of a triangular and sometimes of a circular form, as already said. Some green slime was observed also in the red matter; which however did not proceed from the latter by a change of its colour from red to green, as I at first supposed, but was either a slimy substance arising from the decomposed green *cercariæ*, or some other corrupted slime, which partly kept itself separate from the red matter, and partly mixed itself with it and disappeared. At any rate, I found in it no red, but here and there a shrunk and wrinkled *cercaria*: but it must be observed, that what I

have, in several places, called black, may have been that dark green or almost black colour which M. Müller gives to his *Cercaria viridis*, and which, no doubt, would have shewn itself under a microscope of a stronger magnifying power, if I had been in possession of one at the time.

XV. *Observations on the singular Sagacity of the Rock or Ice Fox\*.*

**D**URING my abode, says Steller, on Behring's island, I had opportunities, more than enough, of studying the nature of this animal, far excelling the common fox in impudence, cunning, and roguery. The narrative of the innumerable tricks they played us, might easily vie with Albertus Julius's history of the apes in the island of Saxenburg. They forced themselves into our habitations by night as well as by day, stealing all they could carry off, even things that were of no use to them; as knives, sticks, clothes, &c. They were so inconceivably ingenious as to roll down our casks of provisions several poods in weight, and then steal the meat out of them so ably, that at first we could not bring ourselves to ascribe the theft to them. As we were stripping an animal of its skin, it often happened that we could not avoid stabbing two or three foxes, from their rapacity in tearing the flesh out of our hands. If we buried it ever so carefully, and added stones to the weight of earth that was upon it, they not only found it out, but shoved away the stones, as men would have done, with their shoulders plying under them, helping one another with all their might. If, thinking to secure it, we put any on the top of a high post in the air, they grubbed up the earth at the bottom, so that the post and all came tumbling down, or one of them clambered up and threw down what was upon it with incredible artifice and dexterity. They watched all our motions, and

\* From *Tooke's View of the Russian Empire.*

accompanied us in whatever we were about to do. If the sea threw up an animal of any kind, they devoured it ere a man of us could come up, to our great disadvantage; and if they could not consume it all at once, they trailed it away in portions to the mountains, where they buried it under stones before our eyes; running to and fro as long as any thing remained to be conveyed away. While this was doing, others stood on the guard, and watched us. If they saw any one coming at a distance, the whole troop combined at once and began digging all together in the sand, till they had so fairly put a beaver or a sea-bear under the surface that not a trace of it was to be seen. In the night-time, when we slept in the field, they came and pulled off our night-caps, and stole our gloves from under our heads, with the beaver-coverings, &c. In consequence of which we always slept with clubs in our hands, that, if they should wake us, we might drive them away, or knock them down.

When we made a halt to rest by the way, they gathered around us and played a thousand tricks in our view; and when we sat still, they approached us so near that they gnawed the thongs of our shoes. If we lay down, as if intending to sleep, they came and smelled our noses to try whether we were dead or alive; if we held our breath, they gave such a tug to the nose as if they would bite it off. On our first arrival they bit off the noses, fingers, and toes of our dead while we were preparing the grave; and thronged in such manner about the infirm and sick, that it was with difficulty we could keep them off. Every morning we saw these audacious animals patrolling about among sea-lions and sea-bears lying on the strand, smelling at such as were asleep to discover whether some of them might not be dead; if that happened to be the case, they proceeded to dissect him immediately, and presently after all were at work in dragging the parts away. Because the sea-lions at night, in their sleep, frequently overlay their young, they examine, as if conscious of that circumstance, every morning, the whole

herd of them one by one, and immediately drag away the dead cubs from their dams.

Seeing, now, that they would not suffer us to be at rest night or day, we were in fact so exasperated at them that we killed them young and old, and plagued them by every means we could devise. When the party awoke in the morning, there always lay two or three at our feet, that had been knocked on the head by some of us in the night; and I can safely affirm, that, during my stay on the island, I slew above two hundred of them myself. The third day after my arrival, I knocked down, within the space of three hours, upwards of seventy of them with a club. They were so ravenous that, with one hand, if we held to them a piece of flesh, they would come to it, although we might have a stick or ax in the other to knock them on the head.

When these busy animals could not get hold of what they wanted, as the clothes we put off, &c. one of them would void his excrement upon it, and all the others which passed would do the same. From all circumstances it was clear to us, that they had had very little communication with human beings, and that the dread of man is not innate in brutes, but must be grounded on long experience.

In October and November they, like the other foxes, were the most sleek and full of hair: in January and February the growth of it is too thick: in April and May they begin to shed their coats: in June and July they had only wool on them, and looked as if they went in waistcoats. In June they drop their cubs, nine or ten in a brood, in holes and cliffs of the rocks. They are so fond of their young, that, to scare us away, they would bark and yelp like dogs, and thereby betrayed their coverts. This mode of preserving their young, probably, has procured them the name of ice or rock foxes. No sooner do they perceive that their retreat is discovered, than, unless disturbed, they drag away the young in their mouths, and hide them in a more secret place. On killing the young, the dam follows the slayer with grievous howlings,

ings, day and night, for a hundred and more versis, and never ceases until she has played her enemy some trick, or is killed by him.

They stink much more horribly than even the red foxes. In rutting time they run together day and night, the males biting each other, from jealousy, like dogs. When they couple, they scream like the cats. In storms and heavy falls of snow, they bury themselves in the snow, and lie still as long as it lasts. They swim across rivers with great agility; will seize the sea-fowl by night on the cliffs when they have settled to sleep; but are themselves frequently victims to the birds of prey. These animals, which are now in such inexpressible numbers on the island, were most probably conveyed there (since there is no other land animal in it) from the Continent on the drift ice, and have been nourished by the great quantity of animal substances thrown up by the sea.

This species is entirely white, and their furs compose a considerable article of commerce.

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XVI. *An Account of Mr. BROWN's Travels through Egypt and Syria, &c.*

[Continued from Page 247.]

ON the 28th of December 1792, Mr. Brown left Kahira to visit Feiûm, a city distant about sixty miles to the south-west. It stands on the principal canal leading from the Nile to the lake Mœris, and is surrounded with cultivated ground producing that profusion of roses for which this place was celebrated, and which were distilled into rose-water. The mode of propagating them was by continued layers; the young twigs thence arising being found to produce the largest and most fragrant flowers. The rose-water was excellent, and sent to all quarters; but the cultivation is now running gradually to decay: wheat and other grain abound in the vicinity.

After passing three days at Feiûm Mr. Brown proceeded towards the lake, of which he wished to make the circuit. It is the Mœris of Strabo and Ptolemy; and the testimony of the latter living in Egypt seems unquestionable. However this may be, the lake now called *Birket-el-kerun*, probably from its extremities bearing some resemblance to horns, shews no mark, as some suppose, of being the production of human art. The length, Mr. Brown says, may probably be between thirty and forty miles; the breadth, at the widest part he could gain, was 5000 toises, as taken with a sextant; that is, nearly six miles. The utmost possible extent of the circuit must of course be thirty leagues. Several fishermen, in miserable boats, are constantly employed on the lake. The water is brackish, like most bodies of water under the same circumstances.

From Feiûm Mr. Brown travelled south-east, and at Hawâra saw two small pyramids of unburnt brick. Returning to Bedis he passed, the day following, the pyramids of Dasbûr; five of which appear successively, besides those of Sakarra. The third, after those of Hawâra, is that of Medun, which has been very elegant. It is composed of large pieces of the usual soft free-stone, joined together with a little cement, and has been hewn off to a straight surface. It would be extremely difficult to ascend to the top, which is now very broad; but it is probable that there was another square completing its summit, which has been removed. The fourth is the most southerly of the four pyramids of Dasbûr, where there are two large and two small. It is in the form of a cone terminating in an obtuse triangle, and is now much damaged. At Sakarra a great number exist, among which ten are of a large size\*.

\* Speaking of the pyramids of Jizé, well known to all who have visited Egypt, Mr. Brown says: "An absurd opinion has recently been stated, that the pyramids are hewn out of the rock on which they stand; but the first ocular inspection would set aside this, the joinings of the stones being every-where marked with cement." This is a flat contradiction of what has been asserted by Bruce.



On the 1st of March 1793 Mr. Brown left Kahira to proceed to Suez, which he reached after a tedious progress of five days. The town is small, and built of unburned brick. It contains twelve mosques, some of which are of stone, but the most are mean buildings. The sea near the town is very shallow, yet there is a small yard for ship-building. The Arab mode of constructing ships is singular. They have no art to bend the timbers; none of them are crooked, except naturally so. They are very slender; and, where the upper and lower ribs join, do not pass over one another, but by the side of each other. The sea here produces few fish. Oysters, indeed, and some others of the shell-kind, are seen: the best fish do not come higher than Cofsir. Meat is scarce; bread of an inferior quality, and sometimes hardly eatable. Butter and milk are brought in small quantities by the Arabs. Water is brought from three several places. It is always bought by the skin, at a considerable price; and if a war were to arise with the Arabs, none could be found.

On the 8th of March 1793 Mr. Brown passed the ford at Suez, and on the 14th arrived at Tûr. On the 18th he left Tûr, and on the 22d, at half past three in the morning, reached the Monastery of Sinai. The convent is large, with a good garden, to which there is a subterranean passage. Within the walls is a small mosque for the convenience of the Arabs. The mountain now called Sinai is high and abrupt: on the north side of it some snow was visible. The whole is a very remarkable rock of red granite, interspersed with spots to which soil has been brought by human labour, or washed down by rain, and in which grow almond-trees, figs, and vines. Numerous rills of excellent water gush from various apertures in the precipice, and wander among the little gardens. Sinai has two summits: the highest, it is believed, may be the Sinai of Moses. The weather being very clear, Mr. Brown observed from Mount Sinai the Eastern Gulph of the Red Sea, which appears very

small, and more round and short than is laid down in the latest maps. Mr. Brown returned to Suez and Kahira, without meeting any thing remarkable on the road.

Mr. Brown's views to the south of Egypt having been frustrated the preceding year, he was reduced to the alternative of abandoning any further projects in that quarter, or of waiting for a more seasonable opportunity. This soon occurred. He had formed a design of penetrating to Abyssinia by the way of Dar-Fûr, as he was taught to believe that he might hope there for the advantages of a regular government, and, with proper management, might expect every favour from the monarch. At the moment of his return from Afsûan to Assiût, the caravan of Jelabs from Dar-Fûr, called *Casslet-es-Soudân* \*, the Soudân caravan, arrived at El-wah. It was then reported, that the sale of their merchandize and slaves, of which they had no great quantity, would be completed in about two months, and that then they would return home. Their stay, however, was protracted during the whole winter, and in the month of March 1793 they commenced their departure from Kahira for the Upper Egypt. They were slow in collecting such things as were necessary, and Mr. Brown made use of the time so allowed to procure information from various quarters respecting the journey.

On the 21st of April 1793 he set out from Bulak, and on the eighth day, the wind having been often unfavourable, reached Assiût. The first care was to provide camels for the route; but, unfortunately they were at that time scarce. He, however, at length obtained five at about 13l. each. A supply of food was also procured for the journey; and the caravan having assembled, after about fifty days, the expected moment of departure arrived. The party having left Assiût on the 25th of May, encamped on the mountain above it till the 28th. On the 31st they arrived at

\* Soudân, in Arabic, corresponds to our Nigritia, merely general words for the country of the Blacks.

Gebel Rumlie, a high rocky mountain which they were to descend. It forms the western side of the ridge, which constitutes, as it were, the wall of Egypt, and the eastern boundary of the low desert in which lie the *Oases*. It consists of a coarse *tufa*, and is of rugged and difficult descent. They were employed four hours and a half the following morning in passing from the foot of the mountain to Ainé Dizé, the first place where water is found, and the northern extremity of the great *Oasis*. As a hot wind blew here during the meridian hours, the thermometer stood at that time, under the shade of the tent, at 116 degrees. In marching from Ainé Dizé to Charjé, eight hours were employed. They left Charjé on the 7th of June, and on Monday the 10th arrived at Beiris. On the 13th they proceeded to Mughes, the last village of the *Oasis* towards the southern desert; which they left on the 15th, and on the 20th reached Seb. This place is marked by the production of a quantity of native alum, as the name imports. The surface near which the alum is found abounds with a reddish stone, and in many places is seen argillaceous earth.

Having left Seb on the 21st, they arrived at Selime on the 23d. On the 24th they rested, and, continuing their route next morning, employed five days more in reaching Leghea. While they remained here, they felt much inconvenience from a suffocating wind, which blew from the south, and raised the sand in clouds. On the 2d of July the caravan left Leghea, and on the 8th, after a severe and fatiguing march, reached the *Bir-el-Malba*, or salt spring. The vicinity of this spring is remarkable for the production of *natron*, which appears under various circumstances, and is of a quality different from that of Terané. It is very white and solid, and, on immersion in water, becomes hot, and discharges a great portion of its air. Small quantities of it are carried by the *jelabs* to Egypt, where it is sold at a high price, and is used principally for making snuff. The water found here is unpalatable and brackish.

They

They remained at Bir-el-Malha till the 12th, and on the 20th encamped at a spot called Medwa. On the 23d they came to the first springs within the limits of Fûr, which are in this place called Wadi Mafrûk. The white ant, *termis*, was here exceedingly vexatious, building its covered way to every thing within the tent, and destroying all within its reach. This, together with the rains, which were now increasing, and began to pour in a torrent through the valley, obliged them to abandon their tents, and to take shelter in the next village (Sweini), where Mr. Brown obtained an apartment in the house of Ali-el-Chatîb, one of the principal merchants established in the country. There he spent eight or ten days, and did not arrive at Cobbé, one of the towns to which the jelabs chiefly resort, till the 7th of August: A Melek, or governor, on the part of the Sultan of Dar-Fûr, generally resides at Sweini; and there all strangers, as well as merchants of the country, coming with the caravan, are obliged to wait till the pleasure of the monarch in disposing of them be known.

As Mr. Brown had come to the country under considerable exceptions from the general rule of merchants trading to this country, and, in the Arabic language, rather as *Daif-es-Sultan*, the king's stranger, in which light he had been hitherto viewed by the natives, he expected to obtain immediate permission to continue his journey to the royal residence. "I observed," says he to the Melek of Sweini and other public officers, "that, intending to visit the Sultan, I should hardly have expected to be put back with frivolous excuses, as the non-payment of duties which you dare not explicitly demand of me, and tributes, under the name of presents, which have never yet been exacted of any stranger. If any duties be payable, beyond what have been already discharged, you are perfectly at liberty to detain all, or such part of the articles I bring with me, as you may judge sufficient to answer your claim, but not to refuse me permission to go to the Sultan, with whom I have business.

Or,

Or, if other reasons operate to prevent my request from being complied with, and if any suspicions prevail relative to my views in coming here, I desire, without further delay, to be furnished with the means of returning to Egypt, before I suffer, as commonly happens to strangers, from the effects of the climate, while I am yet in the habit of travelling, and while the funds are yet unexhausted which should support me in my progress farther."

The misrepresentations which had been made concerning Mr. Brown, and which had by this time reached the Sultan, manacled the hands of the Melek, and prevented his remonstrance from having any effect. Finding, therefore, no mode of advancing till the rest of the caravan should obtain the same permission, he resolved to follow the example of the other jelabs, and wait patiently the event. At length, after the expiration of about ten days, an order from the Sultan arrived, directing that all the jelabs should be allowed to proceed to their houses on paying the duties assessed on them.

Before leaving Kahira, Mr. Brown had been apprised that all commerce in Dar-Fûr was conducted by means of simple exchange. To carry on this, in such a way as not to be grossly defrauded, he was induced to seek for a person who might go through this business for him, at least with some share of probity. The person recommended to him for that purpose had been a slave-broker in the market of Kahira; and though Mr. Brown expected from him that submission and obedience for which the lower classes of the Kahirines are, externally at least, remarkable, he was disappointed in his expectations. The letters with which he was provided for different merchants in this district, under whose roof he might have had a safe lodging, could be of no use till he had seen the Sultan; for, till then, no person knew in what character to receive him. The object of this man, therefore, was to prevent his introduction to the Sultan, and to preclude him from any opportunity of representing his case.

case. They were no sooner arrived at Sweini than he found means to employ one of his associates, who had been some years established in the place, to go to the monarch and instil into his mind suspicions of him as a Frank and an Infidel, who came to the country for no good purpose, and whose designs it behoved him to guard against. The villain himself was in the mean time not idle. As the house in which Mr. Brown lodged had no doors, he took advantage of this circumstance, and his momentary absence, to secrete from a box, which he had broken on the road, a quantity of red coral. By the help of this commodity, Mr. Brown had expected to make his way to the Great. At the end of a few days, this agent returned, bearing a specious letter impressed with the Sultan's seal, ordering that no officer on the road should presume to detain him, or take any thing from him, till he came to the house of *Ibrahim-el-Wobaisbi* (the name of this very agent) in Cobbé, where he was to rest himself till further orders. In this situation, seeing no means of immediate relief, Mr. Brown began to feel impatience, which, as he continued in a state of inactivity, communicated the more rapidly its pernicious influence to his health. On the fourteenth day he was attacked by a fever, attended with extreme pain in the head. How long it lasted he could not tell, having lost his recollection on the second day. It was afterwards recalled by the effect of a dysentery, which lasted for two days, and left him too weak to assist himself.

A little more than a month elapsed, when, the symptoms appearing to diminish, he again pressed to be permitted to visit the residence of the Sultan. But he had reason to regret his impatience; for, having at length obtained leave, he proceeded to El Fasher only to repeat his sufferings. When he arrived at El Fasher, he was first introduced to the Melek *Misellim*, one of the principal ministers. He received him with a rude stare, as an object he was unused to, which was followed by a smile of contempt and aversion.

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He was seated, with some more of the royal attendants, under a kind of awning of cotton cloth, on a mat spread upon the sand. After the common salutations, the Melek and his company entered into conversation on the nature of his visit to the country; while each made remarks on his person, and offered conjectures as to his character and intentions. At length a wooden bowl of *polenta*, and another of dried meat, were set before them. Mr. Brown's illness deprived him of all inclination to eat, and, observing the company not much inclined to invite him to join them, and yet embarrassed to avoid that ceremony, he relieved them by declining it, and desiring them to begin. When they were satiated, a great number of foolish questions were asked him about Europe; some of which he waved, and satisfied them as to others in the best manner he could. When he observed that they grew tired of asking questions, he seized the opportunity of explaining why he came there, and what favour he expected would be shewn to him. "Melek," said Mr. Brown, "having come from a far distant country to Misr (Kahira), I was there made acquainted with the magnificence, the extended empire, and, above all, the justice and hospitality of the king Abd-el-rachmân. Having been used to wander over various countries as a *derwîsh*, I grew desirous of seeing Dar-Fûr. I was told that my person and property would be secure: but since my arrival within the confines, I have found all these assurances fallacious; my inclinations have been thwarted, my person treated with indignity, and my property plundered. I ask redress—I desire the punishment of the man who has robbed me, and restitution of what has been taken. Nor is this all; I particularly desire permission to go to Sennaar, in order to proceed to Habesh. I was prevented from going there last year by the straight road. Habesh is a Christian country, abounding in slaves and gold: there are also many herbs valuable in medicine. Being there, I may easily join my countrymen, merchants who come to

Moccha,

Moccha, in the Bhar Yemeni. I desire the Sultan will allow me to proceed thither; and, if it be necessary, grant me his protection, and three or four persons, deserving confidence, to attend me to the frontiers of Kordofan. I have a small present to offer him, consisting of such things as my circumstances permitted me to bring. I hope he may not refuse to receive it, and to grant me the favour I ask."—He answered: "Merchant, you are welcome to the *Dar*. The king is kind to strangers, and he will favour you in all you wish. Whatever you want, you have only to demand. He has ordered a sack of wheat and four sheep to be sent you. At this time it is not possible to pass through Kordofan: the Sultan has a great army there; and when the country shall be in subjection to him, you may pass unmolested. When you are admitted to his presence, you will tell him who has robbed you, and what you have lost; and he will cause it to be restored." It was now the hour of prayer, and, when the company commenced their ablutions, Mr. Brown retired.

[To be continued.]

XVII. *On the Disappearance of Swallows in Autumn; in a Letter from Mr. PETER COLE to Dr. MITCHILL, dated New-York, September 25, 1798\*.*

**I**N consequence of the epidemic now raging in this devoted city, I have not had an opportunity to give you a detail of what I intimated to you some time ago relative to the disappearance of swallows.

In my early years, a number of my school-companions and myself used to make it a practice to hunt what we termed Ground-Swallows (*hirundo riparia*), in a bank in the neighbourhood of this city, contiguous to where the Jews burial-ground then was. In one of these boyish amusements I recollect two gentlemen passed nearly by us,

\* From the *American Medical Repository*.



who stopped and examined the birds we had dug out of the hill; whereupon a conversation took place relative to the migration of the swallows. The gentlemen both agreed that they were preparing for their winter quarters; and one of them farther added, that he supposed that numbers of them kept in a meadow close by. These observations made such strong impressions on my mind, that they have never since been erased.

After our revolutionary war was over, and my return again into this city in 1783, in order to be convinced of the truth on this curious and controverted subject, I made it a practice to walk around the Collect \*, mornings and evenings, in the seasons when they assembled, in order to mark their flight or return again; but could not discern any thing material until the 3d instant. As I was standing at my door between the hours of five and six in the morning, I observed a very large flock of swallows flying in an easterly direction. I immediately repaired to the pond, where there was already a vast number collected in the reeds and rushes. They continued coming for nearly the space of half an hour, and vast numbers of them were flying over the water in almost every direction. Some of these birds appeared to run on the surface of the water with great rapidity towards the east corner of the pond, and, in the twinkling of an eye, disappeared under the water and rose no more.

They seemed to crowd principally towards that particular spot. But what is somewhat remarkable, and deserves particular notice, is, that among them I observed a number of white ones intermixed with the rest. While I was standing on the edge of the pond with my spy-glass, Mr. Brooks, a particular acquaintance of mine, who lives near the place, came towards me. I mentioned my errand to him. He stood with me a considerable time, and saw the same. I observed to him that there were white ones among them.

\* A pond of fresh water adjoining a marsh in the vicinity of the city of New-York.

He replied, that they were seen three or four days ago. His word may be relied on as a man of strict honour and integrity.

Thus, Sir, I have given you a short sketch of what has come within my own knowledge, and what I earnestly wished to discover. I hope I shall not intrude upon your patience if I subjoin an extract from the Christian's, Scholar's, and Farmer's Magazine \*. It runs thus :

"February 23, 1790. In Ulster county, in the state of New-York, on an island in the Never-Sink-Creek, nearly in the latitude of  $41^{\circ} 30'$  north, a Mr. Baker, in the beginning of the month of March last, having cut down a large hollow beech-tree, to his surprise found the cavity in the tree nearly filled with the common barn-swallows (*hirundo rustica*) of this country, in quantity (by his estimation) nearly two barrels: they were in a torpid state; but carrying some of those which were not injured by the fall of the tree near a fire, they were presently re-animated by the warmth, and took the wing with their usual agility."—This may be depended on as a fact.

I take the liberty also to mention another relation from the American Museum †. It is taken from Mr. Josiah Blakeley's letter to Mr. Carey, dated Baltimore, January 7, 1788. As the piece is of considerable length, I shall only quote a few passages from it. He begins thus :

"The history of our common swallows has long been a problem in ornithology. Whilst people in general supposed them birds of passage, a few, who appear to be better informed, supported the contrary. The opinion of the many was founded on what they thought probable; that of the few on facts. In the year 1780 I was conversing with a person, who lived about twenty miles from Boston, on the phenomenon of the sudden exit but gradual and irregular return of swallows. The gentleman to whom I made these

\* Volume the Second, page 735.

† Volume the Third, page 451-2.

remarks, replied, that they were not birds of passage; and the cause of their sudden disappearance, but irregular return, was, they had a fixed day for immersing in the water, but none for emerging from it. On my doubting his hypothesis, he told me, that as a neighbour of his, not long before, was draining a pond, on a warm day, near the season of the year in which the swallows first appear, his attention was attracted by observing the mud, which, in consequence of draining the pond, had for some time been exposed to the sun, move and appear animated; he then ordered a quantity of this mud to be conveyed into a room in his house, which he caused to be gradually warmed by a slow fire. From this mud there soon arose a number of swallows, hovering over himself and family, who had been spectators of their resurrection.

These few observations, however imperfect, may possibly afford a large field for speculation to the philosophic mind, and lead to useful discoveries. For my own part, I am now become a proselyte to the doctrine of the swallow's remaining in a torpid state during the winter, not only from speculative researches, but from ocular demonstration\*.

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XVIII. *Meteorological Observations made at Padua in the Month of June 1783, with a Dissertation on the extraordinary Fog which prevailed about that Time.* By M. TOALDO †.

**BAROMETER.**—Its greatest elevation was on the 24th and 25th of the month, viz. 28 inches 4 lines; its greatest depression on the 16th, 27 inches 4 lines. In the summer months there is generally very little variation in the baro-

\* Pennant, in his *British Zoology*, Vol. I. p. 414, feels disposed to smile at the accounts given by Olaus Magnus, Derham, and Klein, of the submersion of swallows. Let the physiologist and anatomist reason on the matter as they may, there seems to be positive evidence of the fact. E.

† From the *Journal de Physique*.

meter, and it remains almost always stationary. It appears that it rose very much after the fog, of which I shall soon speak.

**THERMOMETER.**—The month, in general, was cool: its mean heat, which commonly is 19 or 20 degrees, was this year only  $16\frac{1}{2}$ ; for in the latter part of the month the thermometer did not rise above 22·6, and in the beginning it was at 10. I shall observe that it fell four degrees between the 16th and 17th, owing to a storm which came on.

**HYGROMETER.**—Notwithstanding the rain, it always pointed to dryness; which proves the exaltation of the vapours.

**RAIN.**—If we consider the days when it rained little or a great deal, we ought to say that the month was extremely rainy, for it rained twenty-two days: but the rain in general was not abundant, as there fell two inches less of water than usual. This observation is applicable only to the level country; for in the mountains the rain was excessive, and occasioned a very great swell in the rivers and torrents.

But there occurred two particular phenomena to be observed, *viz.* the fog and thunder. On the morning of the 18th, after a storm, which had been preceded by several others, the sun appeared extremely pale through a light fog, which filled the whole atmosphere. This fog became still more condensed the following days; and was not dissipated by the winds, nor even by the storm of the 26th in the morning, accompanied by a great deal of thunder, which was heard all along the direction of the mountains from one sea to the other. This fog still existed in the beginning of July, and seemed to become thicker, at least at certain hours. It did not prevent the sun or stars of the first magnitude from being seen, except in the lower part of the horizon. People could look at the sun without being incommoded, and without using coloured or smoked glass. It appeared of different colours, according to the kind of rays which the difference in the density of the fog suffered to pass. As the  
yellow

yellow and red, being the strongest, were those which pierced it oftenest, the sun appeared like a ball on fire, or of a blood colour; which gave occasion to many whimsical people, whose imaginations were heated, to see there, as in the clouds, the figures of men and animals. Very often the sun, in the higher part of the atmosphere, seemed pale and white by the absence of several coloured rays; and he appeared red when he was lower, because his rays then passed through a greater portion of the atmosphere.

That it may not be imagined that this phenomenon is new in the world, I shall here give a short account of those observed formerly, analogous to it. But it will first be proper to say a few words respecting the cause of this extraordinary fog, which I am inclined to think came from Sicily and Calabria, where there were violent earthquakes. We know, by the accounts given, that the heavens in those countries appeared cloudy after the great shocks, which may be readily believed when we consider the immense exhalations that must have been dispersed throughout the atmosphere. In the month of June the south-east winds prevailed throughout all our country. These winds at Venice are called *Fioriani*, because they first take place on this side of the gulph. It is very probable that these winds, traversing that part of the atmosphere, may have carried with them a large mass of exhalations, which, being stopped by the chain of the Alps, dispersed themselves in Lombardy, and occupied even the Alps, which people, with astonishment, beheld red, or of different colours, according to the position of the sun and of the observer. It does not appear that these exhalations arose from our territory, which was not seen to smoke, as is generally the case in the time of a fog; but it proceeded downwards, as if it had fallen from the atmosphere. It was not seen to touch the earth, except when, by an optical illusion, the nebulous stratum, by being lengthened, appeared united with the sensible horizon. It occasioned no hurt, therefore, to the fruits of the earth; it is said only that it blasted the olives

and vines a little on the elevated grounds. If any suffered in the flat country, the cause may be ascribed to the rains which took place at the time when they were in bloom.

If this fog arose, as I have said, from exhalations disengaged at the time of earthquakes, it must have been dry, and must have contained abundance of earthy, fiery, mineral particles, with a great deal of inflammable air and electric fire. To these may be ascribed the frequent thunder which took place, especially towards the middle of the month. The thunder in general made dreadful ravage, burning houses and destroying men and animals. Letters from Hungary state, that, after several shocks of an earthquake, the city of Krennitz was set on fire by lightning. The same fate was apprehended for Vicenza on the morning of the 26th, the repeated claps of thunder being so violent. Five or six houses were that day struck by the lightning, which occasioned considerable damage. The lightning fell also in about a dozen of places in the neighbourhood, particularly in the mountains.

I shall here subjoin a sort of chronicle of the periods when the sun was seen obscured by fogs; and I am persuaded that many other instances might be found in different authors. This notice will serve to banish every thing marvellous in regard to the fog of 1783; and to shew that nothing happens at present which has not happened formerly, and even attended with more disagreeable circumstances.

*Epochs of the Sun being darkened, and of other similar Phenomena.*

Years of  
Rome.

291 The sun darkened; a comet; fire in the heavens,  
(that is to say, an *Aurora borealis*.) *Julius Obsequens*  
*de Prodigis*.

542 Sun redder than usual, being of a blood colour.

552 The disk of the sun appeared smaller.

554 In the kingdom of Naples, the weather being serene,  
the

Years of  
Rome.

the sun appeared of a blood colour, and the heavens as if on fire, (that is to say, an *Aurora borealis*.)

710 Among the prodigies observed during the year of Cæsar's death, is reckoned that of the sun being darkened, and appearing red.

Cùm caput obscurâ nitidum ferrugine textit,

Impiaque æternam timerant sæcula noctem.

Julius Obsequens relates at more length the prodigies which appeared; particularly torches seen in the heavens, and crowns surrounding the sun, which for several months seemed to emit only a pale feeble light: People, therefore, could look at his disk.

Years of the  
Christian æra.

264 A great earthquake, and darkness for several days.—*Frischbio.*

396 At Constantinople there were such extraordinary storms that the earth shook, while the heavens seemed on fire. At that period people expected the end of the world.

790 And, according to others 798. For seventeen days the heavens afforded no light. This phenomenon was preceded by earthquakes in Candia and Sicily.—*Collect. Acad. de Lancil. Frischbio.*

937 The heavens being serene, the sun was darkened; and his rays, passing through the windows, seemed bloody.

1020 The moon appeared of the colour of blood, and flames fell from the heavens like a tower, (that is to say, a considerable thunderbolt, or globe of fire like a carcass or bomb full of grenades, such as is said to have been observed this year (1783) at the cathedral of Liege. If I am not mistaken, Scheuchzer of Berne relates that he observed one). According to history there were other catastrophes: the sea left its bed, and inundated

Years of the  
Christian æra.

several places in the neighbourhood. The same thing happened during the hurricane of March 11th this year (1783).

1104 The sun and moon in disorder were eclipsed several times, (that is to say, were obscured :) there were seen falling stars, flaming fires, fiery meteors, lightnings, hail; typhons and hurricanes took place, which overturned churches and houses; destroyed men, cattle, and plants; and occasioned great devastation in the fields. This is exactly what happened in 1783.

1154 On the 1st of October, the sky, being serene, appeared all of a sudden quite darkened.

1206 People imagined that they saw in the heavens a human head; and the following year, in Germany, the sun seemed divided into three parts. Similar phenomena may easily deceive the imagination of men, which is generally confused during such events, as was observed in 1783.

1227 An earthquake and comet—the sun of the colour of blood.

1263 The sun obscured, without any clouds, in such a manner as not to give any light.

1383 An earthquake in Swisserland. A large circle afterwards around the sun for several days.

1549 There appeared in the afternoon, for three days in April, a globe all on fire. It is even said, that armies had been seen fighting in the heavens before, and two lions engaged. (These were the sportings of the light of an *Aurora borealis*.)



XIX. *Observations on Pumice Stone, and the Places where found.* By Professor BECKMANN\*.

PUMICE stone, *pumex*, *pierre-ponce*, *pomice*, is a porous, light, friable, rough kind of stone, which floats in water; neither strikes fire with steel, nor effervesces with acids; contains little or no iron, but sometimes more, sometimes less magnesia; and, in a strong heat, becomes fused to glass without the addition of any other substance. On account of its singular properties, an idea was entertained, even in the most ancient periods, that it must have originated in a different manner from other stones. As it was found in many parts floating on the sea, the ancients considered it to be a kind of hardened sea-scum; as from the same superficial grounds the bones of the cuttle-fish, employed for many purposes like pumice stone, are called sea-scum also. More attentive observers, however, perceived that it was indebted for its formation to the force of fire; especially as it was found, for the most part, near volcanoes, and was actually thrown up by them.

It is now known with certainty, that real pumice stone is a volcanic production, both that thrown up by the sea, and that found even in Germany, where there are no burning mountains. The latter kind is a proof that in these districts there must formerly have been volcanoes; and the former, of volcanoes so near the sea that their eruptions could reach it. No place, however, abounds more with this kind of stone than the Lipari islands, particularly Lipari and Vulcano, from which, since the earliest periods †, all Europe has been supplied with this stone, and chiefly by the

\* A chemical examination of it may be found in Cartheuser's *Mixeralogical Essays*; Bergmann's *Opuscula*, III. p. 197; and Achard's *Collection of Physical and Chemical Essays*, I. p. 58.

† Pumices laudatissimi sunt in Æoliis insulis. *Plin. Hist. Nat. lib. xxxvi. cap. 25.*

Sicilians. Of these islands we should have known little more than what has been told us in the fables of the poets, had they not been visited, in the year 1781, by Dolomieu, who published a mineralogical description of them \*; for all other travellers who have given accounts of Sicily say nothing of them, partly because they followed the common routine, and wished to see only such objects as had been seen by others—and partly because these islands lie in a tempestuous sea, where to the danger of shipwreck is added that of being taken by the Barbary cruisers, who hover about in that neighbourhood during the whole summer. Travellers, however, who wish to see more than antiquities, and who are desirous to examine and describe more than things already known, may here expect a rich harvest, if they are accustomed to make observations in regard to natural history: for objects worthy of their notice cannot be wanting in islands where volcanoes of every kind exist, some continually burning, and some which, like *Ætna* and *Vesuvius*, are sometimes at rest, and sometimes in a state of violent eruption; where there are others totally extinct; and besides these, lava of all kinds, and in each degree of calcination, vitrification, and efflorescence †.

The Lipari islands, the *Insulæ Æoliæ* or *Vulcaniæ* of the ancients, lie between Italy and Sicily, but nearer to Sicily, from the coast of which the nearest is distant about thirty Italian miles. Dolomieu makes the number of them to be ten; others say there are eleven. The largest, which is the most fertile and best peopled, is called Lipari. It is eighteen Italian miles in circumference, and contains a

\* See his Voyage to the Liparine islands. Compare also *Viaggi alle due Sicilie e in alcune parti dell' Apennino*, dall' Abate *Laz. Spallanzani*. Pavia, 1793, 8vo. tom. ii.

† In regard to the precise situation of these islands, see Hémán's map: *Sicilia, Sardinia, Corsica, Malta*, 1762, corrected by Zannoni. On the three-sheet map published by Loller in 1770, under the title of *Mer Méditerranée*, the island of *Ustica* is entirely omitted.

small town of the same name. According to Dolomieu, it is the inexhaustible magazine from which all Europe obtains pumice stone; and it has whole mountains of that substance, in which large holes have been cut without any perceptible decrease being observed. Next to Lipari, and nearest to Cape Melazzo in Sicily, lies Vulcano, nearly twelve Italian miles in circumference, and separated from the former by a channel only one Italian mile in breadth. Its fire is never extinguished; and it contains an inexhaustible store of pumice stone, which has a perfect resemblance to that of Lipari. Some of it is collected for foreign trade; but this uninhabited island is visited, at present, merely on account of its wood, which grows on the south side of an ancient crater.

The pumice stone, however, of these islands, is very different in regard to solidity, hardness, and weight; and it may be distinguished into four kinds, one of which only is employed in foreign commerce. The first is grey; has a close grain, imperceptible interstices and fibres; a considerable weight; great compactness; and somewhat of a vitreous fracture. This stone, which can be easily cut, is employed as corner-stones for buildings, and for all kinds of walls in general. The town of Lipari is almost entirely built of it.—The second kind is also grey; but lighter, more porous, and has more perceptible fibres than the former, and does not float in water. It is used for arches; and on that account great quantities of it are carried to Sicily and Naples.—The third is light, porous, and full of fibres; it floats in water; has a silky appearance on the fracture; and is compact and of a hard grain, which renders it exceedingly proper for polishing marble and metals. This is the only kind employed in foreign trade.—The fourth kind is exceedingly white; of a very tender texture, and less compact than the others. It seems to have reached the utmost degree of extension, to which any substance can attain, for its parts to retain a connexion. This kind is fit for no pur-

pose whatever. When it falls into the sea, it floats often to a great distance; and it may be found sometimes on the coast of Sicily and Calabria \*. It is in general remarked, that the whiter pumice stone is, it is always the lighter †.

The most common use of this kind of stone is for polishing almost every kind of substance; and it is exceedingly proper for the purpose, as it is soft enough to be rubbed to a fine powder; and yet its finest particles remain so rough that they can attack and wear down the surface of bodies without making scratches. The powder of vitreous stones would also rub off particles by friction, but, on account of its acute edges, would leave scratches; and to pound it so fine as to prevent this inconvenience, would require much more trouble and time than the pumice stone; and even then, this fine powder of vitreous stones would suffer itself to pass over the bodies to be polished almost like argillaceous earth, without making any impression upon them. The workmen, who employ pumice stone for this purpose, use it either pounded, sifted and washed, or in whole pieces, as the hatmakers, curriers, and some workers in metal. The last must choose such pieces as have fine pores, and are so large that they can assume the form proper for rubbing or scowering. On this account preference is given, in commerce, to that kind of pumice stone which does not consist of too small pieces. In general, it must be light, rough, friable, of a grey colour, and free from sand or any other foreign

\* Popowitsch, in his *Researches respecting the Sea*, p. 347, observes, that this pumice stone is cast by the west wind on the Calabrian shores, and by the north wind on those of Sicily and Greece. He was told there, that it was a substance thrown up by the volcanoes of the Lipari islands. But it may be seen, by Dolomieu's account, that it never can be an article of commerce, as Popowitsch thinks.

† Cronstedt says, in his *Minerology*, that the white pumice stone is produced from the black by its being bleached in the open air. But this is not the case: the white is of that colour when it is thrown up. See Olafsen's *Reise durch Island*, ii. p. 103. Linnæus, therefore, has been guilty of an error in his *Syst. Nat.* iii. p. 181.

parts. When it is to be employed as teeth-powder, it must be pounded remarkably fine; and even then it will attack the teeth too strongly.

In countries where pumice stone can be procured at a cheaper rate than among us, it is pounded and mixed with the mortar used in building. This is done in Italy\*; and the case must have been the same in former times, as pieces of it are frequently to be observed in the mortar of ancient walls. It has this binding property in common with terras, pozzolana, and other volcanic productions. From this circumstance we might be induced to conjecture, that the ancients mixed fine *terra sigillaris* with pumice stone coarsely pounded, and formed it into moulded masses, which they dried in the sun, in order to make those bricks for building, which, as Strabo, Pliny, Antigonus Carystius, Vitruvius, and others†, tell us, with some degree of wonder, swam in the water; and that, on account of their lightness, they were peculiarly well adapted for many useful purposes. They expressly say, that the ancients used, in making them, the mineral employed for cleaning silver-plate, which we may consider to have been pumice stone; though many other kinds of earths are fit for the same purpose. This conjecture has given rise, in modern times, to experiments which have not yet been attended with complete success. It will be difficult, indeed, to obtain bricks so light by mixing clay with finely pounded pumice stone, as it will then form a body too compact and heavy. From a passage in the Travels of Peter Della Valle‡ one might be induced to conjecture, that the art of making swimming bricks was known at Ormus, an island in the Persian Gulph, unless he meant perhaps to say that pumice stone was employed there for building as in

\* Labat's *Reise durch Italien*, iv. p. 16.

† The testimonies of the ancients on this subject I have given in a note to the *Historiæ Mirab.* of Antigonus Carystius, cap. clxxxvii. p. 228.

‡ Della Valle's Travels. Geneva, 1674. fol. 3. p. 239.

Sicily; but in Sicily the heavy kind of pumice stone, which does not swim, is employed for that purpose. It is worthy of remark, that among the so-called Etruscan and other earthen ware, as well as among those which were formerly brought from Japan and China oftener than at present, there were vessels much lighter and thinner than any that can be manufactured in Europe. It is not improbable that Fabbroni may have been so fortunate as to discover this preparation: at any rate, he not long ago laid before the Economical Society of Florence, for examination, a kind of brick, the specific gravity of which was not greater than that of the lightest wood\*.

Most authors, who give an account of pumice-stone, speak of it as if it were to be found in the neighbourhood of all burning mountains. This, however, is false; for it is not found among the productions of all volcanoes, but only near those, as the mineralogists assert, the fire of which has arisen in such strata as have intermixed with them a great deal of feld spar. It is found nowhere in greater abundance than in the Liparine islands, as already said, though large quantities of it are found in Iceland; whereas it is very seldom seen near Vesuvius, and never in the neighbourhood of *Ætna*. The ancients, however, speak of *Ætnean* pumice-

\* After I had written this article, I found in Gren's *New Physical Journal*, Vol. II. part 2. p. 129, a paper translated from the Italian of Fabbroni; by which it appears that he made his brick of a kind of earth dug up near Santa Fiora, in the territories of Sienna, which neither effervesces with acids nor is fusible in the fire, and which, according to his examination, consists of siliceous earth, magnesian earth, and aluminous earth, in the proportions of 0.55, 0.15, and 0.12. This earth, therefore, seems to consist of the same component parts, and almost in the same proportions as the so-called sea-froth. According to the prevailing mode of changing old names and making new ones, Fabbroni calls the above earth *Farina fossilis*, under which is understood, at present, an earth arising from effloresced gypsum.

[For Fabbroni's method of making floating bricks, see *The Philosophical Magazine*, Vol. II. p. 180. Edn.]

stone;

stone; for example, Cornelius Severus, the author of a poetical description of that mountain. Theophrastus speaks also of the pumice-stone of Ætna, which he describes as black and heavy \*. Under this head we may place the *Catinenfis pumex* of Juvenal †, though this phrase will admit of another explanation; and perhaps the poet meant only to indulge in a little occasional raillery against the celebrated voluptuaries of Catina or Catana. I well know that we cannot expect from poets, in general, the accuracy which must be observed by naturalists; but those who consider the passage as admitting of no doubt, may support it by the testimony of Gioeni ‡, who found pumice-stone, perfectly like that of Lipari, in the neighbourhood of Ætna, during the eruption of 1787; but he adds, that nothing of the kind had ever been found near Ætna before.

XX. *Eighth Communication from Dr. THORNTON, Physician to the General Dispensary, relative to Pneumatic Medicine.*

CASE OF PARALYSIS CURED BY THE INHALATION OF VITAL AIR.

MR. HUITSON, who dissects for Mr. Cruickshank and Mr. Wilson, eminent teachers in the school of the late Dr. Hunter, had a paralytic affection of the right hand, which deprived him of its motion, and it felt to the other hand al-

\* See the faulty German translation of his work on stones, § 40. p. 120. I shall here occasionally observe, for the sake of those who are fond of comparing the accounts of the ancients and moderns, that a kind of *traps* was employed for mill-stones in the time of Theophrastus and Strabo. *Εἰς τὰ αὐτῶν λαλεῖν γινέται λόγος μυλῶν.* Strabo, Lib. VI. p. 413. The ancients were acquainted also with the use of that kind called by Cronstedt the Rhenish mill-stone; a good description of which has been given by Collini in *Journal d'un Voyage*, Mannheim 1776. 8. p. 301. Compare also my *Physikalisch-Oekon. Biblioth.* Vol. VII. p. 455 and 519.

† Sat. VIII. 16.

‡ See Von Sall's *Collection towards a Natural History of the Kingdom of the Two Sicilies*, 1790. 8. l. p. 172.

ways remarkably cold. The paralysis seemed chiefly seated in the muscle of the thumb. I advised him the trial of electricity; and we observed, as well as those who accompanied him, that the electric spark did not fly with a crackling noise to the paralytic muscles. Trying a piece of dead meat we found the same phenomenon. We then had recourse to inhalation of vital air mixed with atmospheric, and he inhaled from six to eight quarts vital air. The muscle, now receiving oxygenated blood, afterwards caught the electric spark very readily, and a genial warmth was diffused throughout the paralytic hand. This was not a solitary observation, but constant; and it seems to me very forcibly to prove the animating principle derived from the oxygen of the air to the muscular fibre; a principle not, as represented by Mayow, the most subtle, spiritual, and ætherial, but one that can be made obvious to our senses in the form of air, adhering to the calces of metals, and capable now of being conceived even by the most gross understandings.

The patient, I am happy to add, by this combination of external and internal stimulants, was completely restored, and has continued many months perfectly well.

As the case is short, I will say a few words on the combination of remedies. The Faculty, and others, are always crying out for the trials of the airs *alone*, and forget that in their own practice they employ a variety of means. Thus, although exercise is recommended, is the stomach neglected to be braced and stimulated?

The following case from John Hunter\* is very illustrative of this position:

“A lady, of what is called a nervous constitution, arising in some degree from an irritable stomach, often troubled with flatulencies, and what are called nervous head-achs, with pale urine at those times, uncomfortable feelings and often sinkings, had a tumor removed from the breast, and likewise near the arm-pit: nothing appeared uncommon for a few

\* *Vida Hunter on the Blood*, p. 412.



days, when very considerable disorders came on. She was attacked with a shivering, or cold fit, attended with the feel of dying, and followed with cold sweats. It being supposed she was dying, brandy was thrown in, which soon brought on a warmth, and she was relieved. The fits came on frequently for several days, which were also relieved by brandy; and she took, in one of the most violent, half a pint of brandy. While under these affections, she had the bark as a strengthener; the musk occasionally, as a sedative, in pretty large quantities; camphorated jalap frequently, as an antispasmodic; and, towards the last, she took the valerian in large quantities: but whatever effects these might have in lessening the disease, on the whole *they were certainly not equal to it without the brandy.*"

John Hunter judiciously adds: "A question naturally occurs: Would *the brandy alone*, if it had been continued as a medicine, have cured her without the aid of the other medicines? The other medicines, I think, certainly could not have done it; nor do I believe that the brandy could have been continued in such quantity as to have prevented their returns: if so, then *the two modes were happily united*, the one gradually to prevent, the other to remove immediately the fits when they came on."

## INTELLIGENCE,

AND

## MISCELLANEOUS ARTICLES.

### LEARNED SOCIETIES.

#### AMERICAN PHILOSOPHICAL SOCIETY.

**T**HIS Society has recently published the following circular letter:

"The American Philosophical Society have always considered

sidered the antiquity, changes, and the present state of their own country as primary objects of their research; and, with a view to facilitate such discoveries, a permanent committee has been established, among whose duties the following have been recommended as requiring particular attention:

“ 1. To procure one or more entire skeletons of the Mammoth, so called, and of such other unknown animals as either have been, or hereafter may be discovered in America.

“ 2. To obtain accurate plans, drawings, and descriptions of whatever is interesting (where the originals cannot be had); and especially of ancient fortifications, tumuli, and other Indian works of art: ascertaining the materials composing them, their contents, the purposes for which they were probably designed, &c.

“ 3. To invite researches into the natural history of the earth, the changes it has undergone as to mountains, lakes, rivers, prairies, &c.

“ 4. To inquire into the customs, manners, languages, and character of the Indian nations ancient and modern, and their migrations.

“ The importance of these objects will be acknowledged by every lover of science, and, we trust, sufficiently apologize for thus troubling you; for without the aid of gentlemen who have taste and opportunity for such researches, our means would be very confined. We therefore solicit your communications, now or in future, on these subjects; which will be at all times thankfully received, and duly noticed in the publications of the Society.

“ As to the first object, the committee suggest, to gentlemen who may be in the way of inquiries of that kind, that the Great Bone Lick on the Ohio, and other places where there may be mineral salt, are the most eligible spots for the purpose, because animals are known to resort to such places.

“ With respect to the second head, the committee are desirous that cuts in various directions may be made into many of the tumuli, to ascertain their contents, while the diameter  
of

of the largest tree growing thereon, the number of its annulars, and the species of the tree, may tend to give some idea of their antiquity. If the works should be found to be of masonry; the length, breadth, and height of the walls ought to be carefully measured, the form and nature of the stones described, and specimens of both the cement and stones sent to the committee.

“ The best methods of obtaining information on the other subjects will naturally suggest themselves to you, and we rely on a disposition favourable to our wishes.

“ The Committee consist of the following gentlemen, *viz.*  
*Thomas Jefferson*, President of the American Philosophical Society, at Monticello in Virginia.

*James Wilkinson*, Commander of the Army, at Head Quarters.

*George Turner*, of the Western Territory, near Cincinnati.

*Dr. Caspar Wistar*, Vice-Pref. of the A. P. S.

*Dr. Adam Seybert*, Secretary of ditto.

*C. W. Peale*, and

*Jon. Williams*,

} in Philadelphia.

“ Your communications may be addressed to any one of the Committee; but the articles you may think proper to furnish, should be sent to this place.

In behalf of the Committee, I am, respectfully,

Sir, your obedient servant,

J. WILLIAMS, Chairman.”

At the meeting of this Society, January 10, 1799, among other donations and communications, the following were announced as having been received :

A communication from Mr. Andrew Ellicot, determining the latitude and longitude of the town of Natchez—A letter from Dr. Priestley on the decomposition of water—Three barrels, containing the bones of non-descript animals, and two meteorological journals kept at Detroit and on a voyage to Michilimacnac on the Lakes, by Gen. Wilkinson—A specimen of mica from New Hampshire—Experiments and

observations on the atmosphere and marshes, by Dr. Seybert—And a paper concerning the pernicious effects of the *Equisetum hyemale*, or rough horse-tail, when eaten by horses; by Mr. Barton.

### MISCELLANEOUS.

#### AMERICAN ENTOMOLOGY.

With pleasure we announce to naturalists Mr. Baker's collection of American insects. In his museum at New-York may be seen about three thousand species, principally arranged according to the Linnæan system. They were collected chiefly by Mr. Jotham Fenton, who has been nearly six years engaged in entomological pursuits. The species of this collection were mostly caught in the neighbourhood of the cities of New-York and New-Haven.

#### FIRE-BALL.

A very remarkable phenomenon of this kind was seen in the county of Kent, and the neighbourhood, on Sunday the 22d September, at about 35 minutes past eight in the evening. It came from the south-west, and passed in a south-east direction till it sunk in the horizon. It seemed to be nearly of the size of the moon, but of an oval form, or rather in the form of an ox's bladder, the thickest end going foremost. The sky, which was dark and stormy, was illuminated during its passage more brightly than by the full moon. Its colour was a vivid white, inclining a little to yellow; and it seemed as if followed by a few smaller globules, or rather large sparks of a red colour, which kept at the same distance from its body during the whole time that it was visible, which was for several seconds.

#### ASTRONOMY.

A comet is now visible in our hemisphere. It was first seen on the 6th inst. near the lower side of the quadrangle of *Ursa Major*, from which it has been moving about  $3^{\circ}$  in 24 hours, following the direction of the tail, and through one shoulder of *Bootes*.

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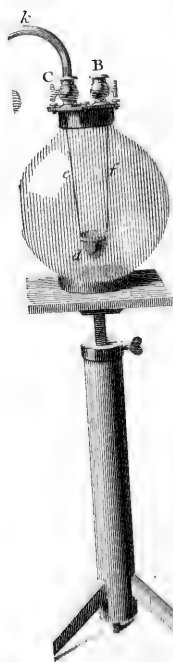
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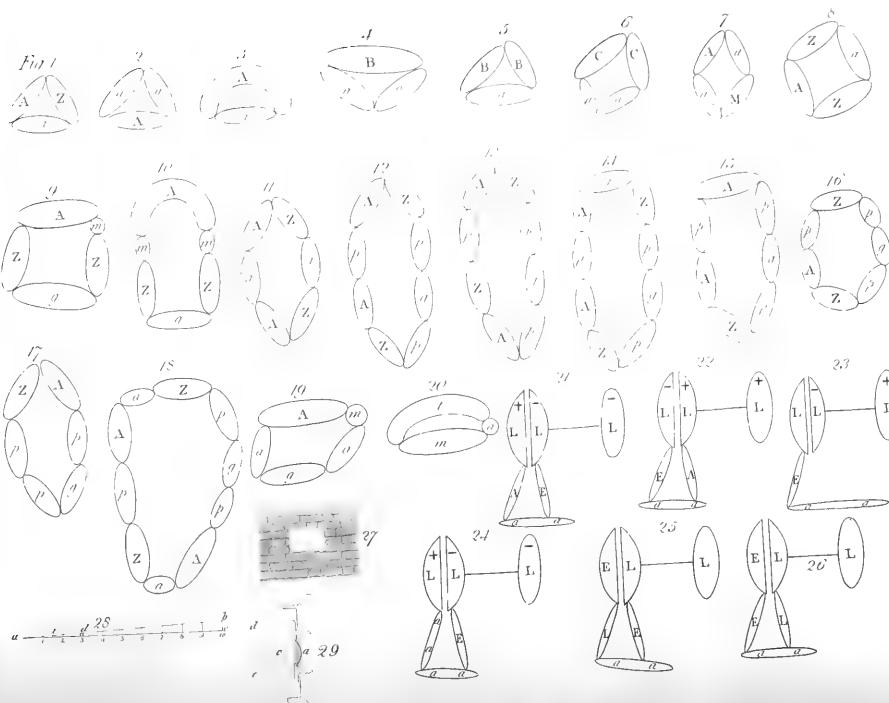


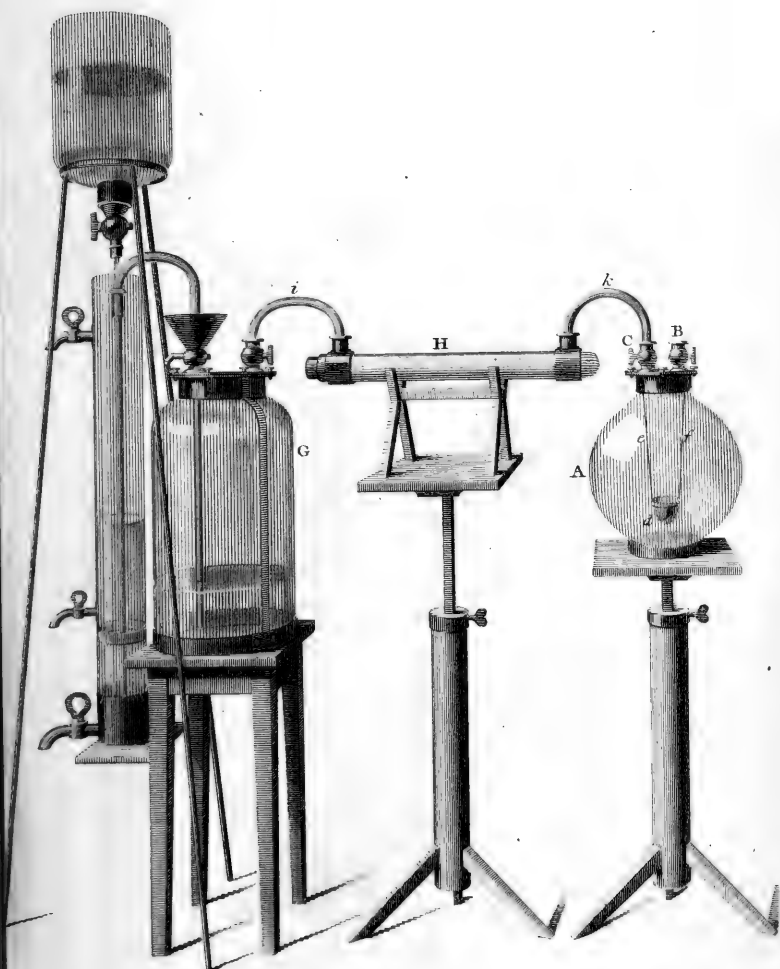
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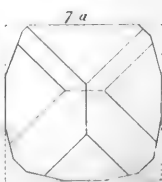
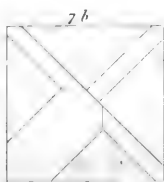
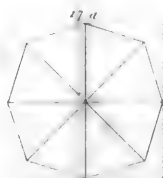
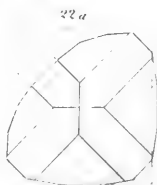
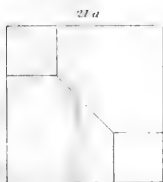
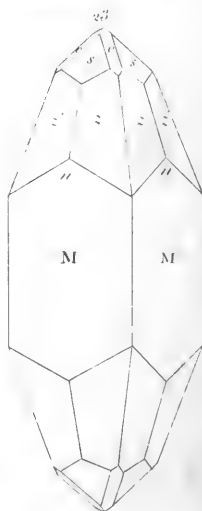
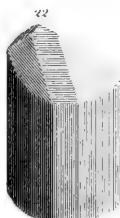
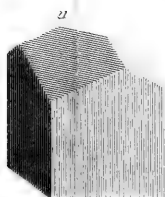
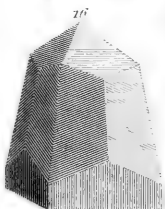
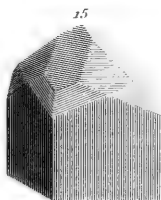
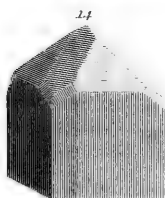
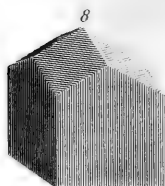
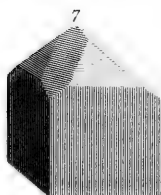
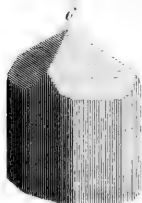
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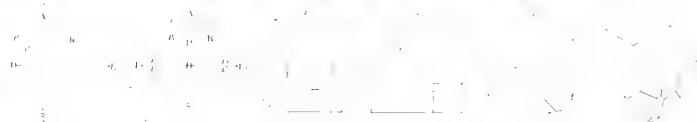
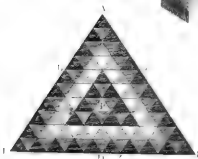
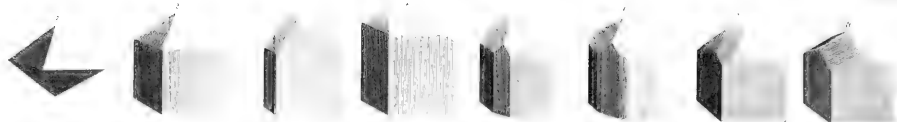




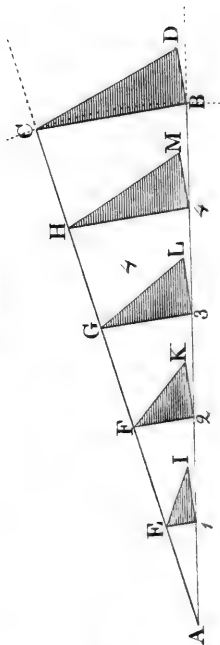
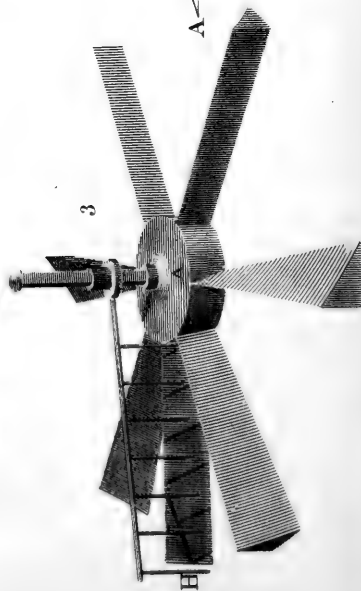
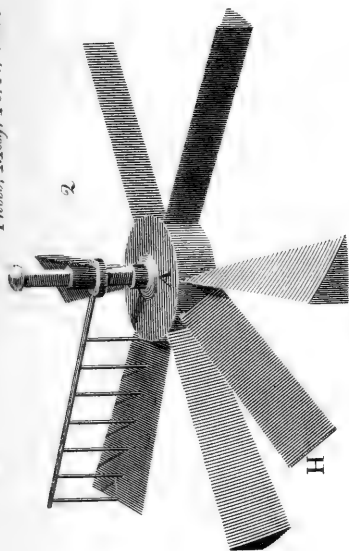
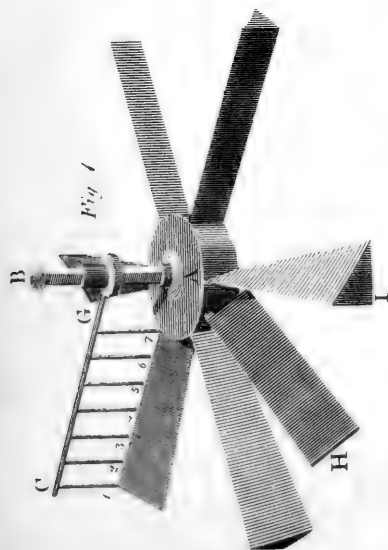




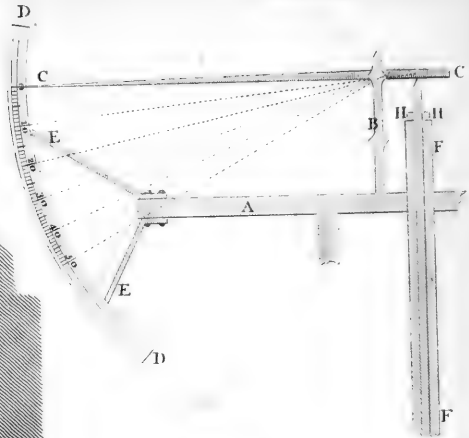




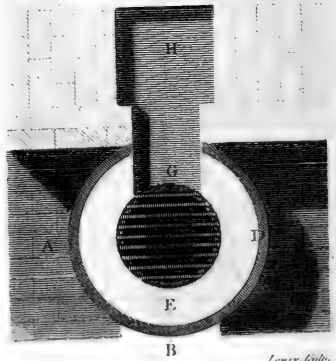
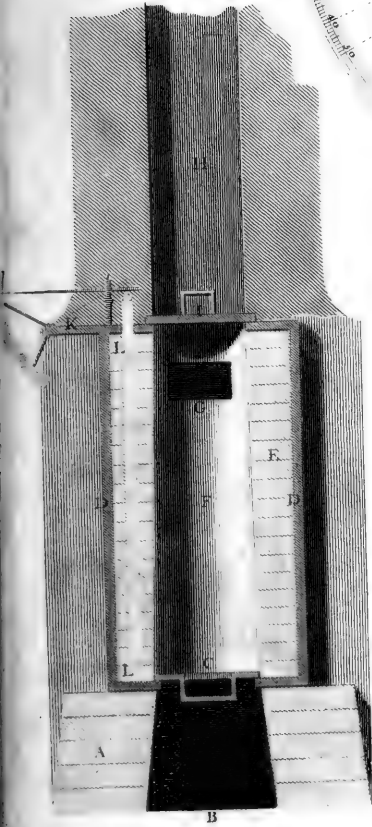








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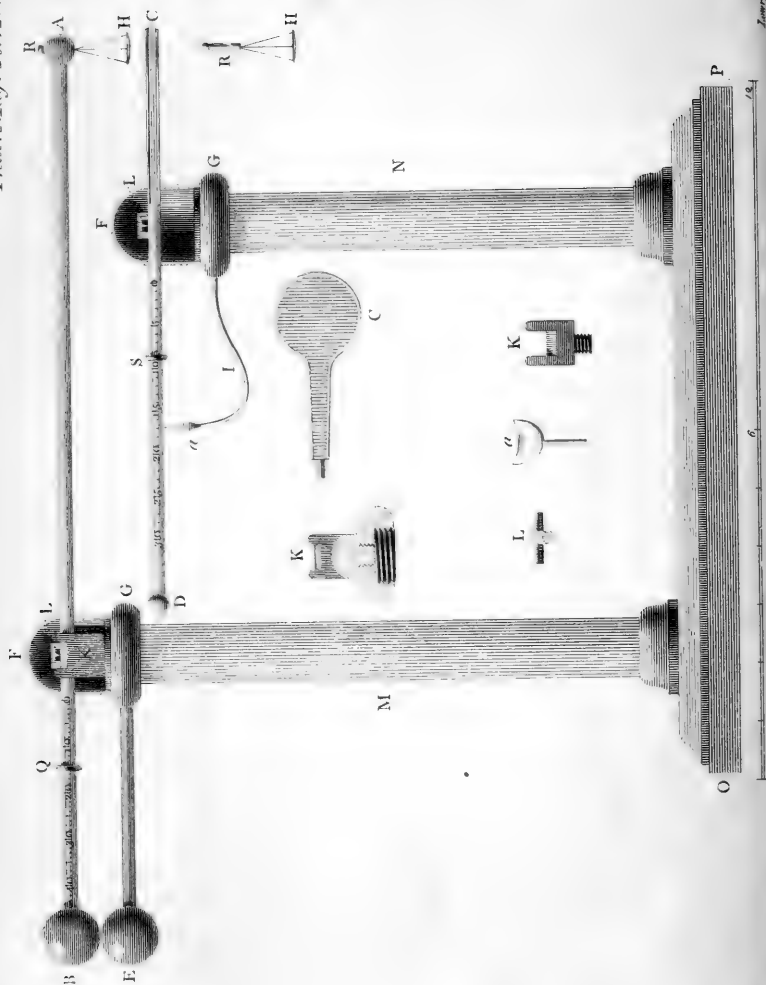


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*Fig. 3.*



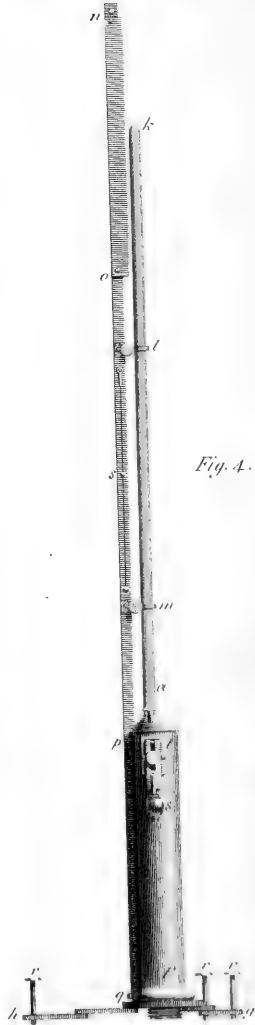
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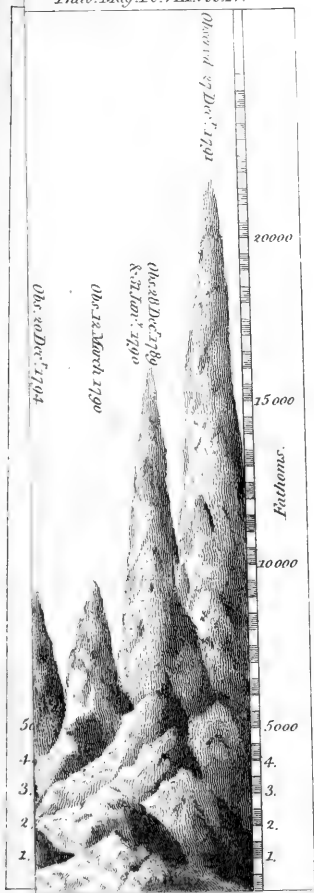


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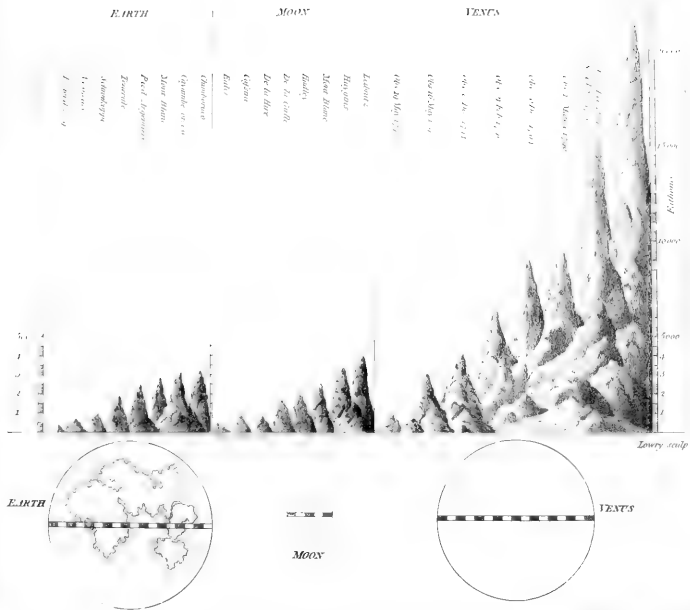


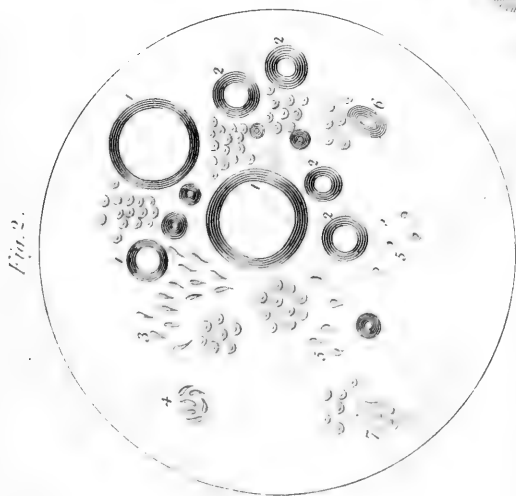
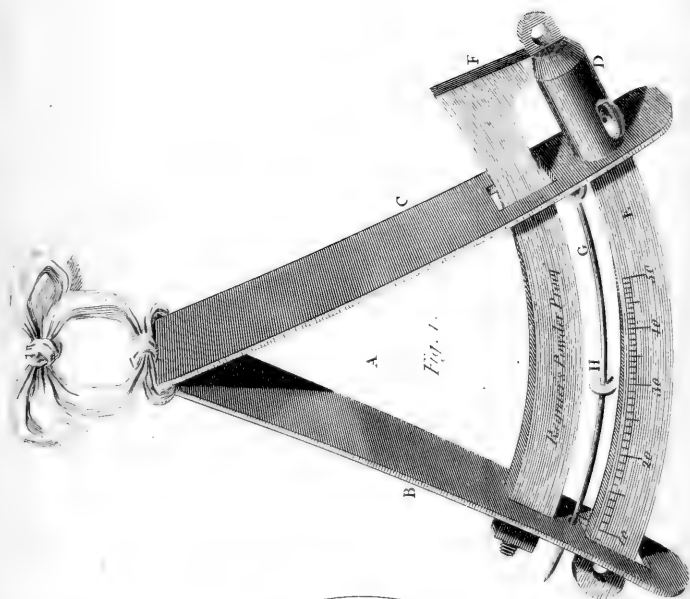


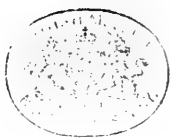


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# ENGRAVINGS.

by Mr. Robert Salmon, of Woburn, Bedfordshire, for which a Bounty was voted to him by the Society for the Encouragement of Arts, &c.—The new Machine invented and employed by the late Mr. Cuffance to make his unrivalled Vegetable Cuttings for the Microscope; drawn and engraved from the Machine itself, now in the possession of Dr. Thornton; a Plate to explain the Method of forming Figures with Sand on Vibrating Surfaces, according to Dr. Caladni's Theory—The Furnace employed by the French Chemists in their Examination of C. Clouet's Process for the immediate Conversion of Iron into Cast Steel by means of Carbonat of Lime; and the New Steel-Yard invented by C. Paul of Geneva, Number XIII. is illustrated with a Plate of Figures to explain Volta's Theory of Galvanism—Apparatus employed by Dr. Van Marum for the Combustion of Phosphorus in Oxygen Gas. Number XIV. is illustrated with a 4to Plate relative to the Structure of the Crystals of Oxyde of Tin—and a Plate illustrating the best Construction of the Vanes of Windmills as far as concerns the Angle of Weather.

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 \* \* \* Dr. Whyte's Favour came to hand too late for insertion in the present Number, but shall certainly appear in the next.

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